Sandia National Laboratories/New Mexico

PROPOSAL FOR RISK-BASED NO FURTHER ACTION ENVIRONMENTAL RESTORATION SITE 147 BUILDING 9925 SEPTIC SYSTEMS OPERABLE UNIT 1295

May 1997

Environmental
Restoration
Project

United States Department of Energy
Albuquerque Operations Office

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Prepared by
Sandia National Laboratories/New Mexico
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Albuquerque, New Mexico

Prepared for
the U.S. Department of Energy

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ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
BA	butyl acetate
bgs	below ground surface
BTEX	benzene, toluene, ethylene, and xylene
COC	constituents of concern
DOE	Department of Energy
DOU	Document of Understanding
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ES&H	Environmental Safety and Health
KAFB	Kirtland Air Force Base
µg/kg	micrograms per kilogram
mg/kg	milligrams per kilogram
mrem	millirems
NEPA	National Environmental Policy Act
NERI	Northeast Research Institute
NFA	No Further Action
NMED	New Mexico Environment Department
OU	Operable Unit
PCB	polychlorinated biphenyl
PCE	perchloroethene
pCi/L	picocuries per liter
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SNL/NM	Sandia National Laboratories/New Mexico
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TNT	trinitrotoluene
UTL	upper tolerance limit
VOC	volatile organic compound

1.0 INTRODUCTION

1.1 Description of ER Site 147

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a No Further Action (NFA) decision based on confirmatory sampling for Environmental Restoration (ER) Site 147, Building 9925 Septic Systems, Operable Unit (OU) 1295. ER Site 147 is listed in the Hazardous and Solid Waste Amendments Module IV (EPA August 1993) of the SNL/NM Resource Conservation and Recovery Act (RCRA) Hazardous Waste Management Facility Permit (NM5890110518-1) (EPA August 1992).

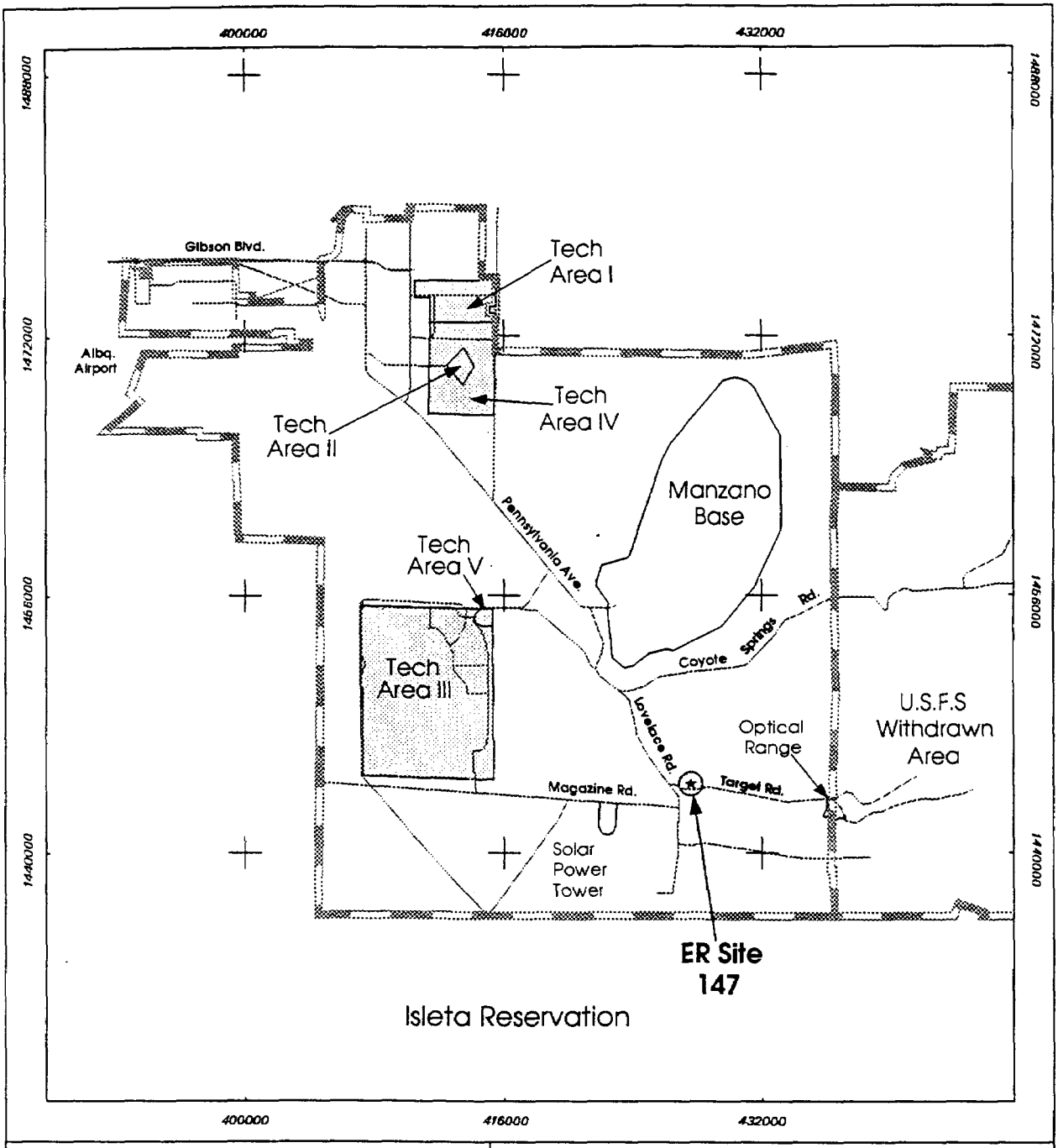
SNL/NM occupies 2,829 acres of land owned by the Department of Energy (DOE), with an additional 14,920 acres of land provided by land-use permits with Kirtland Air Force Base (KAFB), the United States Forest Service, the State of New Mexico, and the Isleta Pueblo. SNL/NM has been involved in nuclear weapons research, component development, assembly, testing, and other research and development activities since 1945 (DOE September 1987).

ER Site 147 is located in the Coyote Test Field area in the southern part of KAFB, approximately 1.5 miles north of the Isleta Pueblo boundary, and 0.25 mile east of Lovelace Road. It is reached by traveling south on Lovelace Road, and then east on Optical Range Road (also known as Target Road) for a distance of 0.25 mile (Figure 1-1).

ER Site 147 consists of two adjacent but separate areas. The first area encompasses two septic systems north and west of Building 9925 (Figure 1-2), and the second area includes a third septic system south of Building 9925 that is now under the asphalt pavement of Optical Range Road (Figure 1-3). The drainfield north of Building 9925 was connected to the "north system septic tank" on Figure 1-2, and will be hereinafter referred to as the "north system." The drainfield west of the building served the "west system septic tank" on Figure 1-2, and will be called the "west system" in the remainder of this report. The system under the pavement south of the building will hereinafter be referred to as the "south system." These two areas encompass approximately 0.58 acre of essentially flat-lying land at an average mean elevation of 5,701 feet above mean sea level (amsl).

Vegetation consists predominantly of grasses including grama, muhly, dropseed, and galleta. Shrubs commonly associated with the grasslands include sand sage, winter fat, saltbrush, and rabbitbush. Cacti are common, and include cholla, pincushion, strawberry, and prickly pear (SNL/NM March 1993).

The surficial geology in the ER Site 147 area consists of upper Pleistocene alluvial fan deposits. The alluvial fan materials originated from the Manzanita Mountains that are about 2 miles east of ER Site 147, and typically have a moderate to high (sand + gravel)/(silt + clay) ratio, are poorly sorted, and exhibit moderately connected lenticular bedding. Based on drilling records of similar deposits at KAFB, the alluvial fan materials are highly heterogeneous, and are composed primarily of medium to fine silty sands with frequent coarse sand, gravel, and cobble lenses. Individual beds range from 1 to 5 feet thick with a preferred east-west orientation, and have moderate to low hydraulic conductivities.



Legend

- ER Site 147
- Major Roads
- KAFB Boundary
- Technical Areas

Sandia National Laboratories, New Mexico
Environmental Restoration Geographic Information System

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone
1927 North American Horizontal Datum, 1929 North American Vertical Datum

DRAFT
Unclassified
1:120000

0 5000 10000
Scale in Feet

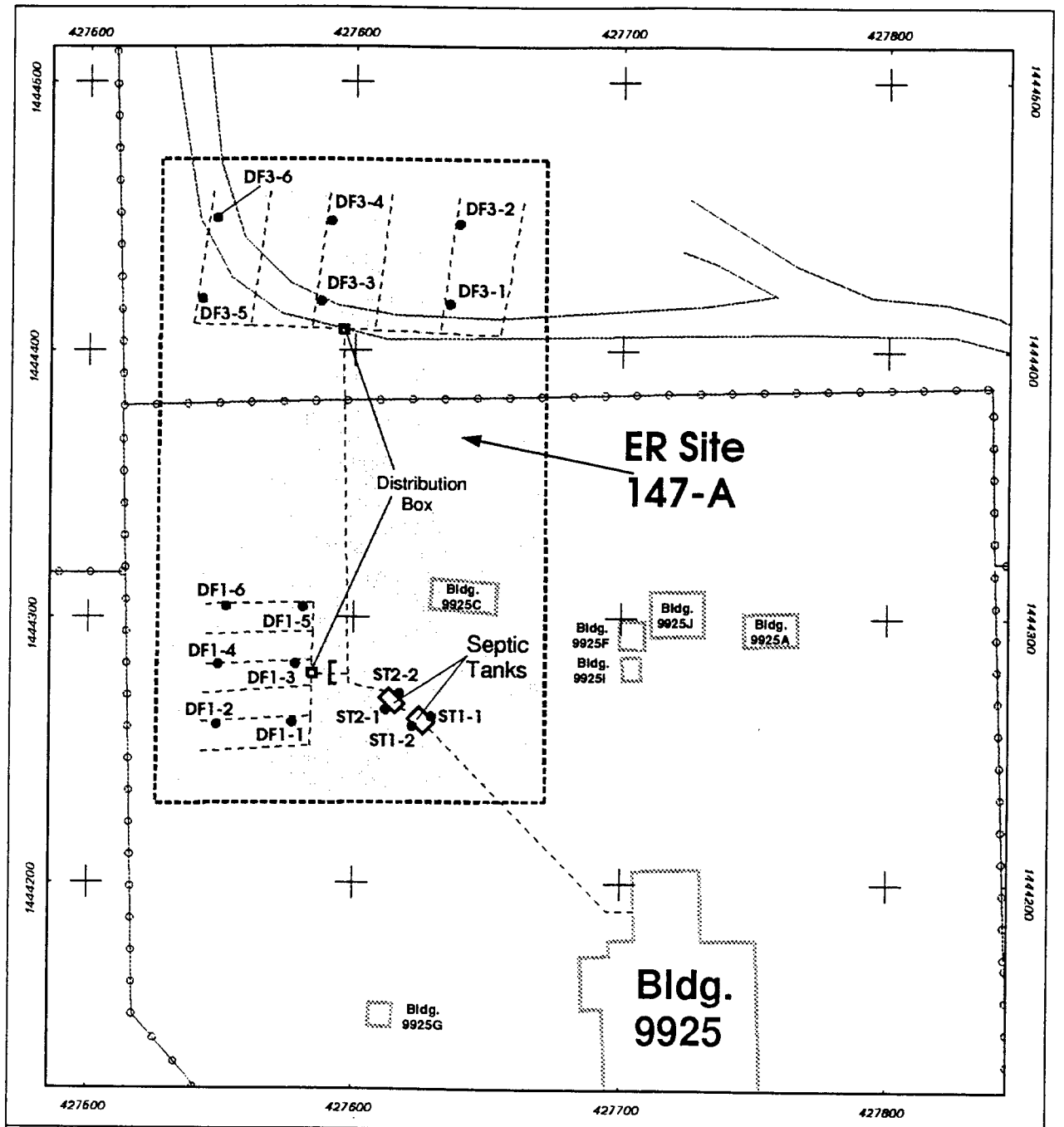
0 1200 2400
Scale in Meters

N

GIS

FIGURE 1-1
Location Map for ER Site 147
Sandia National Laboratories,
New Mexico

scmorri SNL GIS ORG. 7512 07/03/96 MAPID=960997



Legend

- Boring Location
- Fences
- KAFB Roads
- Buildings
- Sanitary Sewerline, Drainfield
- Septic Tank, Distribution Box
- ER Site 147

Sandia National Laboratories, New Mexico
Environmental Restoration Geographic Information System

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone
1927 North American Horizontal Datum, 1929 North American Vertical Datum

DRAFT
Unclassified
1:840

0 30 60
Scale in Feet

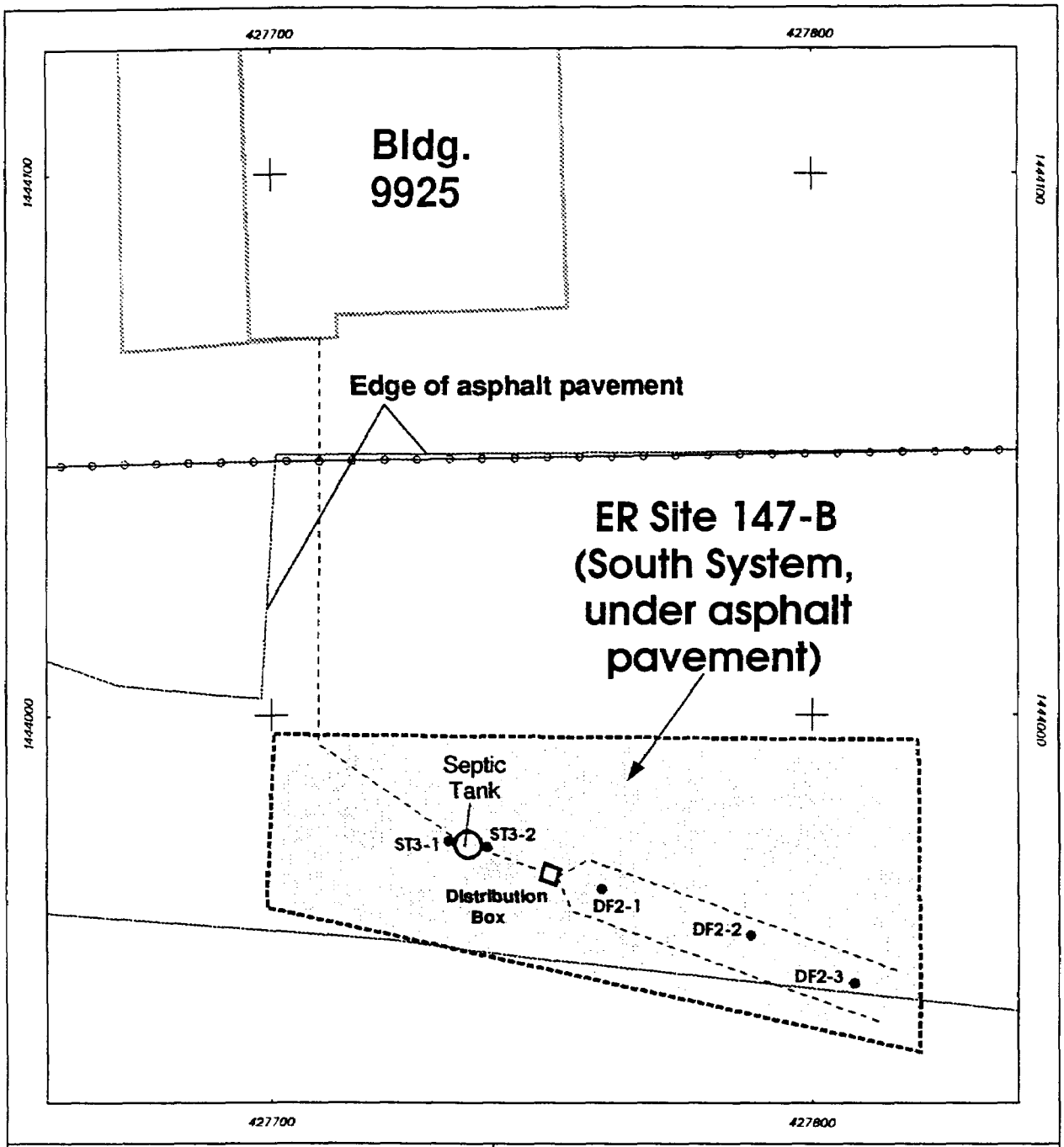
0 7.2 14.4
Scale in Meters

N

GIS

FIGURE 1-2
Site Map for ER Site 147 - West and North Systems
Sandia National Laboratories,
New Mexico

scmorri SNL GIS ORG. 7512 07/09/98 MAPID=961010



Legend

- Boring Location
- Fences
- KAFB Roads
- Septic Tank, Distribution Box
- Sanitary Sewerline, Drainfield
- Buildings
- ER Site 147

Sandia National Laboratories, New Mexico
Environmental Restoration Geographic Information System

Unclassified

0 15 30
Scale in Feet

0 2.6 7.2
Scale in Meters

FIGURE 1-3
Site Map for ER Site 147 - South System
Sandia National Laboratories,
New Mexico

scmorri SNL GIS ORG. 7512 07/09/96 MAPID=961011

Plates XIII and XV of SNL/NM December 1995 (the "geology report") indicate that the alluvial fan sediment package is approximately 100 feet thick beneath the site, and is believed to rest on Pennsylvanian Madera Group, Wild Cow Formation bedrock. Wild Cow Formation sedimentary rocks consist of interstratified marine and non-marine siltstone, sandstone, calcarenite, and conglomerate (SNL/NM March 1996a). Plate XV of the "geology report" also shows that ER Site 147 is situated above a paleo-trough incised into the buried Wild Cow Formation bedrock surface that drained in a southwesterly direction.

On a more regional scale, ER Site 147 is located in a structurally complex zone of faulted bedrock ramps that lie between the sediment-filled Albuquerque Basin to the west, and the uplifted Manzanita Mountains to the east. The ramps are separated by generally west-dipping normal faults that trend northeast (and locally northwest), and exhibit down-to-the-west displacement (SNL/NM December 1995).

The closest monitoring wells to ER Site 147 are the pair of wells designated KAFB-1901 and KAFB-1902 (SNL/NM August 1996). These wells are 300 feet apart, were installed in July 1992, and are located about 2,200 feet southeast of the site. The KAFB-1901 borehole passed through 140 feet of alluvial fan sediments and then penetrated Wild Cow Formation bedrock from 140 feet below ground surface (bgs) to the borehole total depth of 240 feet bgs. The borehole was plugged back to 130 feet bgs, and was completed as a monitoring well with the screen zone extending from 79 to 104 feet bgs. The KAFB-1902 borehole was drilled to 120 feet bgs and did not reach bedrock. It was completed as a monitoring well in alluvial sediments with a screened zone also from 79 to 104 feet bgs (SNL/NM January 1997).

Plate IV of SNL/NM March 1996a indicates the water-table elevation was approximately 5,685 feet amsl beneath ER Site 147 in the fall of 1995, which would put the depth to groundwater beneath the site at approximately 16 feet. However, the deepest confirmatory sampling borehole at the site was drilled to 23 feet bgs in January 1995, and no groundwater was encountered. Nonetheless, available data indicate that groundwater is present at a relatively shallow depth beneath the site. The latest KAFB-1902 water level measurement taken in September 1996 was 88.49 feet bgs (5,661.78 feet amsl) (SNL/NM September 1996). Water levels are not measured in KAFB-1901 because of its proximity to KAFB-1902. Local groundwater flow is believed to be in a generally westerly to southwesterly direction in the immediate vicinity of this site (SNL/NM March 1996a). The nearest production wells are northwest of ER Site 145 and include KAFB-1, 2, 4, 7, and 14, which are between 5.9 to 8.1 miles from the site.

1.2 No Further Action Basis

This request for an NFA decision for ER Site 147 is based on analytical results of confirmatory soil samples collected at the site and a risk assessment analysis. Review and analysis of the ER Site 147 soil sample analytical data indicate that concentrations of constituents of concern (COCs) detected in soils at this site are less than (1) SNL/NM or other applicable background concentrations, or (2) proposed Subpart S or other action levels or (3) derived risk assessment action levels. Thus ER Site 147 is being proposed for an NFA decision based on confirmatory sampling data and risk assessment demonstrating that hazardous waste or COCs that may have been released from this solid waste management unit (SWMU) into the environment pose an

acceptable level of risk under current and projected future land use, NFA Criterion 5 of the Environmental Restoration Document of Understanding (DOU) (NMED April 1996).

2.0 HISTORY OF ER SITE 147

2.1 Historical Operations

The following historical information has been excerpted from several sources, including SNL/NM March 1993, IT March 1994, and SNL/NM November 1994a.

Building 9925 was constructed in 1959 and functioned as the Coyote Test Field Headquarters from 1968 until the late 1980s. Little information could be gathered concerning the early history of operations. Interviews with personnel familiar with the facility indicated that Building 9925 is located at the north end of the former Area Y, one of three primary explosive test areas in the 1950s. It was also referred to as the Moonlight Shot Area, which involved the firing of mock weapons and weapon components constructed of depleted uranium. A machine shop in the north end of the building occasionally used small quantities of solvents, but there is no history of discharges to the septic systems. There are two restrooms with floor drains and two showers in Building 9925. There is no floor drain in the machine shop. Estimated effluent volumes for Building 9925 range from 100 to perhaps as much as 4,000 gallons per day during intermittent periods of high activity at the facility.

An SNL/NM Facilities Engineering drawing with the earliest date of 1959 shows that the south system is on the south side of Building 9925 under the present Optical Range Road pavement (SNL/NM 1959) (Figure 1-3), and that it consisted of a 750-gallon septic tank and associated drainfield composed of two parallel drainlines that are 70 feet long and 10 feet apart. A later modification (date unknown) to this same drawing shows the south system as "abandoned in place." The manhole leading into the septic tank was found to be filled with soil when ER Project personnel removed the manhole cover in May 1994 (SNL/NM May 1994).

The west system was constructed in 1965 or 1966 to serve Building 9925, according to another SNL/NM Facilities Engineering drawing (SNL/NM August 1965 and November 1980); it is assumed the south system tank was filled with soil at around this time. The west system is located about 150 feet northwest of the building, and consisted of a 1,500-gallon septic tank plumbed into a drainfield composed of six 40-foot long parallel distribution lines (Figure 1-2).

The third (north) system was installed to replace the west system, which was possibly undersized or malfunctioning. A third SNL/NM Facilities Engineering drawing dated August 20, 1980 (SNL/NM August 1980), shows the planned construction configuration for the new north system, so it is assumed that it was installed, and the west system abandoned, in approximately the fall of 1980. The north system tank was installed immediately northwest of and in-line with the abandoned west system tank, and plumbed to a drainfield composed of six 50-foot long parallel drainlines. This drainfield is located about 250 feet north of Building 9925, and outside of the facility perimeter fence (Figure 1-2). The north system also is no longer used. Building 9925, as of June 1991, was connected to an extension of the City of Albuquerque sanitary sewer system (SNL/NM June 1991).

2.2 Previous Audits, Inspections, and Findings

ER Site 147 was first listed as a potential release site in the RCRA Facility Assessment (RFA) report to the U.S. Environmental Protection Agency (EPA) in 1987 (EPA April 1987). This report contained a generic statement about this and many other SNL/NM septic systems where sanitary and industrial wastes may have been discharged during past operations. This SWMU was included in the RFA report as Site 79, along with other septic and drain systems at SNL/NM. All the septic system sites included in Site 79 are now designated by individual SWMU numbers.

Liquid and sludge septage samples were collected from the north and west system septic tanks in July 1992. The introductory text in the Septic Tank Monitoring Report (SNL/NM June 1993) for the Building 9925 septic tank sampling states that samples were collected from "... the inactive septic tank and seepage pit serving Building 9925". There is no seepage pit at this site; apparently the north system tank was mistaken for a seepage pit. It is therefore assumed that the samples consisted of composited material from both tanks, rather than individual samples from each tank. The liquid supernate samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), total metals, selected radionuclides, and several other miscellaneous analytes. Trace levels of one VOC (trichloroethene, or TCE) were detected; no SVOCs, pesticides, or PCBs were identified. Very low levels of a number of metals, phenolic compounds, nitrates/nitrites, formaldehyde, fluoride, cyanide, oil and grease, and gross alpha and beta radioactivity were also detected. The sludge samples (composed of 92.2% water) were analyzed for total metals, gross alpha and beta activity, tritium, and selected radionuclide constituents. A number of metals, low gross alpha and beta activity, and a few radionuclides were detected. Analytical results for the 1992 septic tank septage sampling are summarized in Section 6.1.

3.0 EVALUATION OF RELEVANT EVIDENCE

3.1 Unit Characteristics and Operating Practices

There are no safeguards inherent in the drain systems from Building 9925 or in facility operations that could have prevented past releases to the environment. As discussed in Section 2.1, effluent was released to the Building 9925 septic tanks and drainfields when the septic systems were active.

3.2 Results of Sampling/Surveys

3.2.1 Summary of Prior Investigations

The following sources of information were used to evaluate ER Site 147:

- Results of samples collected from the septic tanks in 1992 (SNL/NM June 1993), 1994 (SNL/NM May 1994), and 1995 (SNL/NM January 1995d and August 1995);
- Results of four surveys, including an archaeological/cultural resources survey (Hoagland and Dello-Russo 1995), a sensitive or special status species or environments survey (IT February 1995), a geophysical survey (Lamb 1994), and a passive soil gas survey (NERI June 1995);
- Confirmatory subsurface soil sampling conducted in January 1995 (SNL/NM January 1995b);
- Approved RCRA Facility Investigation (RFI) Work Plan and addenda for OU 1295, Septic Tanks and Drainfields (SNL/NM March 1993, November 1994a, December 1994, January 1995a, March 1995, and May 1995; and EPA September 1994, January 1995, and March 1995);
- Photographs and field notes collected at the site by SNL/NM ER staff;
- SNL/NM Facilities Engineering building drawings; and
- SNL/NM Geographic Information System data.

3.2.2 Septic Tank Sampling

Septage samples were collected from the ER Site 147 north and west system septic tanks for waste characterization purposes. The results of the analyses, along with the site history, guided selection of COCs for the confirmatory soil sampling. Analytical results are summarized in Section 6.2 for all post-1992 septage sampling.

West System Septic Tank Samples

Additional waste characterization liquid and sludge samples were collected from the west system septic tank in May 1994 (SNL/NM May 1994). The liquid samples were analyzed for phenolic compounds, the eight RCRA total metals, three isotopic uranium constituents, tritium, and additional radionuclides using SNL/NM in-house gamma spectroscopy screening. Only a low concentration of barium and below-reporting limits concentrations of arsenic and silver were identified in the liquid samples. The sludge samples were analyzed for VOCs, SVOCs, phenolic compounds, the eight RCRA metals using the Toxicity Characteristic Leaching Procedure (TCLP), explosive compounds, and additional radionuclides using SNL/NM in-house gamma spectroscopy screening. Explosives compounds were selected as an analyte for the west tank only because it was in service from the late 1960s through the early 1980s when it was more likely that the COC was present in the facility. Below-reporting-limit concentrations of two VOCs, seven SVOCs, and phenolic compounds were identified in the material. No explosive compounds were detected, and very low activity levels of seven radionuclides were identified in the gamma spectroscopy screening.

A waste characterization sludge sample was collected from the west system tank in January 1995 and was analyzed for three isotopic uranium radionuclides (SNL/NM January 1995d). Very low activity levels of the three isotopes were detected in the sludge.

North System Septic Tank Samples

A second round of liquid and sludge waste characterization samples was collected from the north system septic tank in January 1995 (SNL/NM January 1995d). The liquid samples were analyzed for SVOCs, explosives compounds, the eight RCRA total metals, isotopic uranium, and tritium. Explosives compounds were selected as an analyte for the north tank liquid only because the two tanks are in series and the line to the drainfield is connected to the north tank. SVOCs and explosive constituents were not detected, and only low concentrations of two metals (barium and lead) were identified in the liquid. Low activity levels of three isotopic uranium radionuclides were detected, and tritium was not identified in the liquid. The sludge samples were analyzed for VOCs, SVOCs, the eight RCRA total metals, three uranium isotopes, and were also screened for additional radionuclides using SNL/NM in-house gamma spectroscopy. Five VOCs, one SVOC, seven of the eight RCRA metals, and low activity levels of three uranium isotopes were detected in the samples. A number of additional radionuclides were also identified in the gamma spectroscopy screening of the sludge.

3.2.3 Archaeological/Cultural Resources Survey

An archaeological/cultural resources survey was conducted at each of the 23 OU 1295 ER sites (including ER Site 147) in 1994, and no archaeological or cultural resources of concern were identified at any of these heavily disturbed sites (Hoagland and Dello-Russo 1995).

3.2.4 Sensitive/Special Status Species Survey

A field survey was conducted in the KAFB area in 1994 to identify sensitive or special status species or environments at numerous ER sites. All 23 of the OU 1295 ER sites were examined during this field effort, and no sensitive species or environments were identified at any of the septic and drain system sites (IT February 1995).

3.2.5 Geophysical Surveys

Several geophysical surveys using Geonics™ model EM-31 and EM-38 ground conductivity meters were performed in the area of the west and south systems in late 1993 and early 1994 to attempt to locate areas of moist soils around these systems, and to identify locations of pipe runs. The EM-31 instrument was used for deeper surveys (up to 18 feet bgs), and the EM-38 was employed for shallower work (within 5 feet of the surface). A possible moist area was identified north of the west drainfield (Lamb 1994). Geophysical techniques were not useful in determining the locations of the drainlines in the west and south drainfields; the actual drainline locations (Figure 1-2) were later determined using a backhoe (SNL/NM September 1994).

3.2.6 Passive Soil-Gas Surveys

Two separate passive soil-gas surveys were conducted in the south and west system areas in June 1994 (SNL/NM June 1994), and a third survey was conducted in the north system drainfield area in November 1994 (SNL/NM November 1994b). PETREX™ sampling tubes were used to help identify any releases of VOCs and SVOCs that may have occurred via the septic systems at this site. A PETREX™ soil-gas survey is a semi-quantitative screening procedure that can be used to identify many volatile and semivolatile organic compounds. This technique may be used to guide VOC and SVOC site investigations. The advantages of this sampling methodology are that large areas can be surveyed at relatively low cost, the technique is highly sensitive to organic vapors, and the result produces a measure of soil vapor chemistry over a two- to three-week period rather than at one point in time. Each PETREX™ soil-gas sampler consists of two activated-charcoal coated wires housed in a reusable glass test tube container. At each sampling location, sample tubes are buried in an inverted position so that the mouth of the sampler is about 1 foot below grade. Samplers are left in place for a two- to three-week period, and are then removed from the ground and sent to the manufacturer, Northeast Research Institute (NERI), for analysis using thermal desorption-gas chromatography/mass spectrometry. The analytical laboratory reports all sample results in terms of "ion counts" instead of concentrations, and identifies those samples that contain compounds above the PETREX™ technique detection limits. In NERI's experience, levels below 100,000 ion counts for a single compound (such as perchloroethene [PCE] or TCE), and 200,000 ion counts for mixtures (such as benzene, toluene, ethylene, and xylene (BTEX) or aliphatic compounds [C4-C11 cycloalkanes]), under normal site conditions, would not represent detectable levels by standard quantitative methods for soils and/or groundwater (NERI June 1995).

Two maps showing the soil gas sampling locations in the north, west, and south septic system areas, and the analytical results of the three ER Site 147 passive soil gas surveys conducted at ER Site 147 are presented in Section 6.3. Eighteen PETREX™ tube samplers (numbers P-555

through P-564, and P-566 through P-573 on the map in Section 6.3) were placed in a grid pattern that covered the north system drainfield area at this site (SNL/NM November 1994b). Twenty-four PETREX™ samplers (numbers P-85 through P-108 on the Section 6.3 map) were placed in a grid pattern that covered the west system drainfield area, and also covered the area around the north and west system septic tanks (SNL/NM June 1994). Finally, twelve more samplers (numbers P-73 through P-84 on the second PETREX™ location map in Section 6.3) were placed in a grid arrangement that covered the south system septic tank and drainfield area under the Optical Range Road pavement (SNL/NM June 1994). Seven of the twelve south system PETREX™ samplers (P-77, and P-79 through P-84) were inserted through small boreholes drilled through the asphalt paving and installed in soil immediately beneath the pavement. Four other samplers (P-73 through P-76) were placed in an unpaved area on the south side of the road, and the twelfth sampler (P-78) was installed in the center of the soil-filled septic tank manhole.

All of the PETREX™ samplers placed at this site were analyzed for two individual constituents (PCE and TCE) and two groups of compounds (BTEX and aliphatic compounds). Potentially significant levels of PCE, BTEX, and aliphatic compounds in soil gas were detected at a number of the south system PETREX™ samplers located beneath the pavement, while significant levels were not detected in soil gas at any of the five samplers placed at unpaved locations. However, no VOCs were detected except for the common laboratory-introduced contaminants in the follow-up soil samples collected from around the south system septic tank and drainfield. The low VOC levels detected in soil gas beneath the pavement could reflect near-surface emanations from the asphalt paving material itself, or fluid leakage from vehicles traveling or parked on the road surface.

Potentially detectable levels of PCE, BTEX, and aliphatic compounds also were detected in soil gas at a number of the PETREX™ sampling locations in the west system drainfield area, and in the vicinity of the west and north septic tanks. However, the locations with higher ion counts are somewhat randomly scattered and do not appear to correspond to the configuration of the drainfield, and also are not in the immediate area of the two septic tanks (Section 6.3 map). The VOCs detected in soil gas probably originated from motorized equipment and vehicles parked in the equipment yard west of Building 9925. VOCs were not detected in any of the soil samples collected from boreholes in the west system drainfield, or around the two septic tanks.

Finally, potentially significant levels of BTEX or aliphatic compounds in soil gas were identified at only two of the eighteen PETREX™ sampling locations in the north system drainfield area. Except for analytical laboratory-introduced compounds, VOCs were not detected in any of the soil samples collected from the north system drainfield boreholes.

3.2.7 Confirmatory Soil Sampling

Although the likelihood of significant releases of hazardous constituents at ER Site 147 was considered low, confirmatory soil sampling was conducted to determine whether COCs above background or action levels were released via the septic systems at this site. A backhoe was used in September 1994 to determine the location, dimensions, and depths of the west and north system drainfields, which had no surface expression. A faint organic-type of odor was noted when some of the soils were being excavated in the west drainfield. No visible evidence

of soil discoloration, staining, or odors indicating residual contamination was observed when the north drainfield was being located (SNL/NM September 1994). Also, no odors or other evidence of contamination was noted when (1) soil samples were collected from the three drainfield areas and around the three septic tanks in January 1995 (SNL/NM January 1995b), or (2) when soils were excavated from around the north and west system septic tanks as part of the ER Site 147 septic tank waste removal and decontamination operation in January 1996 (SNL/NM January 1996a). The upper photograph of Figure 3-1 shows the backhoe excavation work to locate the north drainfield drainlines. No attempt was made to tear up Optical Range Road to locate the south system drainlines; the locations were estimated based on an SNL/NM Facilities Engineering drawing (SNL/NM November 1980).

Once the drainfields were located, soil samples were collected from boreholes within each drainfield, and from both sides of each of the north, west, and south septic tanks (SNL/NM January 1995b). The confirmatory soil sampling program was performed in accordance with the rationale and procedures described in the approved Septic Tank and Drainfields (ADS-295) RFI Work Plan (SNL/NM March 1993), and ER Site 147-pertinent addenda to the RFI Work Plan approval process (listed in bullet item number 4 of Section 3.2.1 above). A summary of the types of samples, number of sample locations, sample depths, and analytical requirements for confirmatory soil samples collected at this site is presented in Table 3-1.

The following method was used to evaluate the potential for COCs in the north system area. Soil samples were collected from one boring on either side of the north system septic tank, and from six borings next to, and near each end of, every other north drainfield lateral line (Figure 1-2). The north system septic tank soil samples were collected from one interval in each of the two boreholes starting at the outside bottom of the tank, which was measured to be 9 feet bgs (SNL/NM January 1995b). Soil samples were collected from two intervals in each of the six north drainfield boreholes. The top of the shallow intervals started at the bottom of the drain line trenches, which were 9 feet bgs on average in this drainfield (SNL/NM September 1994), and the lower (deep) intervals started at 10 feet below the top of the upper intervals, or 19 feet bgs.

A similar sampling scheme was used to evaluate the west system. Confirmatory soil samples were collected from one boring on either side of the west system septic tank, and from six borings next to, and near each end of, every other west drainfield lateral line (Figure 1-2). The west system septic tank soil samples were collected from one interval in each of the two boreholes starting at the outside bottom of the tank, which was measured to be 9 feet bgs at this site (SNL/NM January 1995b). West system drainfield soil samples were also collected from two intervals in each of the six west drainfield boreholes. The top of the shallow intervals started at the bottom of the drainline trenches, which were 5 feet bgs on average in this drainfield (SNL/NM September 1994), and the lower (deep) intervals started at 10 feet below the top of the upper interval, or 15 feet bgs.

South system soils were assessed in the following manner. At each of the five sampling locations, a solid metal Geoprobe™ drill rod was used to punch a hole through the Optical Range Road pavement to the underlying soil surface. The Geoprobe™ sampling equipment was then inserted through each punched hole, and soil samples were collected from beneath

Trench excavated with a backhoe to partially expose and locate the north system drainfield drainlines. September 9, 1994. View looking east.

View of the five south septic system soil sampling borehole locations (marked with flagging) drilled through the Optical Range Road pavement. January 9, 1995. View looking northwest.

Figure 3-1. ER Site 147 Photographs

Table 3-1
Confirmatory Sampling Summary Table

Sampling Area	Analytical Parameters	Number of Borehole Locations	Top of Sampling Interval(s) at Each Boring Location	Total Number of Investigative Samples	Total Number of Duplicate Samples	Date(s) Samples Collected
North System Septic Tank	VOCs	2	9'	2		1/4/95
	SVOCs	2	9'	2		"
	TNT Screen	2	9'	2		"
	RCRA metals	2	9'	2		"
	Isotopic uranium	2	9'	2		"
North System Drainfield	VOCs	6	9' and 19'	12	1	1/9 & 10/95
	SVOCs	6	9' and 19'	12	1	"
	TNT Screen	6	9' and 19'	12		"
	RCRA metals	6	9' and 19'	12	1	"
	Isotopic uranium	6	9' and 19'	12	1	"
	Tritium composite	6	9' and 19'	2		"
	Gamma spec. composite	6	9' and 19'	2		"
West System Septic Tank	VOCs	2	9'	2		1/4/95
	SVOCs	2	9'	2		"
	TNT Screen	2	9'	2		"
	RCRA metals	2	9'	2		"
	Isotopic uranium	2	9'	2		"
West System Drainfield	VOCs	6	5' and 15'	12	1	1/3 & 4/95
	SVOCs	6	5' and 15'	12	1	"
	TNT Screen	6	5' and 15'	12		"
	RCRA metals	6	5' and 15'	12	1	"
	Isotopic uranium	6	5' and 15'	12	1	"
	Tritium composite	6	5' and 15'	2		"
	Gamma spec. composite	6	5' and 15'	2		"
South System Septic Tank	VOCs	2	10'	2		1/9/95
	SVOCs	2	10'	2		"
	TNT Screen	2	10'	2		"
	RCRA metals	2	10'	2		"
	Isotopic uranium	2	10'	2		"
South System Drainfield	VOCs	3	5' and 15'	6		1/5/95
	SVOCs	3	5' and 15'	6		"
	TNT Screen	3	5' and 15'	6		"
	RCRA metals	3	5' and 15'	6		"
	Isotopic uranium	3	5' and 15'	6		"
	Tritium composite	3	5' and 15'	2		"
	Gamma spec. composite	3	5' and 15'	2		"

Notes: RCRA = Resource Conservation and Recovery Act
TNT = Trinitrotoluene
Spec. = Spectroscopy
VOCs = Volatile organic compounds
SVOCs = Semivolatile organic compounds

the pavement. Samples were collected from one boring on either side of the south system septic tank, and from three borings near the beginning, middle, and ends of, and between the two parallel drainfield drainlines, which were shown on an SNL/NM Facilities Engineering drawing to be 10 feet apart (Figure 1-3). The south system sampling locations (marked with pin flags) are shown in the lower photograph of Figure 3-1. South system septic tank soil samples were collected through the pavement from one interval in each of the two boreholes starting at the outside bottom of the tank, which was estimated to be 10 feet bgs based on measured depths of septic tanks at other ER septic system sites. South drainfield soil samples were also collected through the pavement from two intervals in each of the three drainfield boreholes. The top of the shallow interval started at the bottom of the drain line trenches, which were estimated to be 5 feet bgs based on configurations of other OU 1295 septic system drainfields, and the lower (deep) interval started at 10 feet below the top of the upper interval, or 15 feet bgs.

The Geoprobe™ sampling system was used to collect subsurface soil samples at this site. The Geoprobe™ sampling tool was fitted with a butyl acetate (BA) sampling sleeve and was then hydraulically driven to the top of the designated sampling depth. The sampling tool was opened, and driven an additional 2 feet in order to fill the 2-foot long by approximately 1.25-inch diameter BA sleeve. The sampling tool and soil-filled sleeve were then retrieved from the borehole. In order to minimize the potential for loss of volatile compounds (if present), the soil to be analyzed for VOCs was not emptied from the BA sleeve into another sample container. The filled BA sleeve was removed from the sampling tool, and the top 7 inches were cut off. Both ends of the 7-inch section of filled sleeve were immediately capped with a Teflon membrane and rubber end cap, sealed with tape, and placed in an ice-filled cooler at the site. The soil in this section of sleeve was then submitted for a VOC analysis.

Soil from the remainder of the sleeve was then emptied into a decontaminated mixing bowl. Following this, additional 2-foot sampling runs were completed in order to recover enough soil to satisfy sample volume requirements for the interval. Soil recovered from these additional runs was also emptied into the mixing bowl, and blended with soil from the first sampling run. The blended soil was then transferred from the bowl into sample containers using a decontaminated plastic spatula.

Drainfield and septic tank soil samples were analyzed for VOCs, SVOCs, and RCRA metals by a commercial laboratory, and were also screened for trinitrotoluene (TNT) by an SNL/NM laboratory. Also, to determine if radionuclides were released from past activities at this site, discrete samples were collected from all septic tank and drainfield sampling intervals and were analyzed for three isotopic uranium radionuclides by a commercial laboratory. In addition, SNL/NM waste management personnel requested additional limited soil sampling to confirm that radionuclides had not been released to the environment at this site. Composite samples were therefore collected from shallow and deep intervals in each of the three ER Site 147 drainfields. The shallow interval composite samples consisted of blended fractions of soil from the shallow sampling intervals in each drainfield. Likewise, the deep interval composite samples were composed of blended soil fractions from the deep sampling intervals in each drainfield. These composite samples were analyzed for tritium by a commercial laboratory, and were also screened for additional radionuclides using SNL/NM in-house gamma spectroscopy.

As shown in Section 6.4, analytical results of soil samples collected at ER Site 147 indicate that six of the eight RCRA metals that were targeted in the Site 147 investigation were either not detected, or were detected in concentrations below the background upper tolerance limit (UTL) or 95th percentile concentrations presented in the SNL/NM study of naturally-occurring constituents (IT March 1996). However, 7 of the 38 soil samples collected at this site contained either barium or lead at concentrations above the background UTL or 95th percentile concentrations for the respective metals, as follows. The shallow interval sample from the west drainfield borehole DF1-2 and samples from the two boreholes around the south system septic tank (ST3-1 and ST3-2) (Figure 1-2) contained 355, 245, and 241 milligrams per kilogram (mg/kg) of barium, respectively; these values exceed the SNL/NM soil background UTL value of 214 mg/kg for that metal. Also, lead concentrations above the SNL/NM background 95th percentile concentration of 11.8 mg/kg were detected in soil samples from four locations. The deep interval sample from the north drainfield borehole DF3-3, the shallow and deep interval samples from north drainfield borehole DF3-6, and the deep interval in the south drainfield borehole DF2-2 (Figure 1-2) contained 39.7, 12.3, 14.4, and 23.3 mg/kg, respectively of lead. However, the highest concentrations of barium and lead detected in the ER Site 147 soil samples (355 and 39.7 mg/kg, respectively) are less than 1/10 of the proposed Subpart S or EPA action levels of 6,000 and 400 mg/kg, respectively for the two metals. Therefore, ER Site 147 passed the Subpart S screening criteria for metals.

No explosives were detected in the colorimetric screening method at any sample location or depth. SVOCs were detected only at one location in each the north and west drainfields: di-n-butyl-phthalate was detected in one of the shallow intervals in the north drainfield while bis(2-ethylhexyl) phthalate and phenol were found in one of the deeper intervals in the west drainfield. The highest SVOC concentration detected was 58 micrograms per kilogram (µg/kg), far below the laboratory reporting limit of 330 µg/kg for the three compounds. The trip blank was not analyzed for SVOCs, but it is possible that the presence of these three compounds is due to laboratory contamination. Six different VOCs were detected in a number of the soil sample locations in all three drainfields and around all the septic tanks, but all were below the laboratory reporting limits except for one detection of acetone at 17 µg/kg. However, the analysis of the trip blank for that sample shipment detected acetone at a concentration of 150 µg/kg. The results for these analyses are summarized in Section 6.4.

As shown in Section 6.4, tritium was detected in soil moisture from two of the six composite soil samples analyzed for tritium at this site. The two west drainfield shallow and deep interval composite samples contained 450 and 350 picocuries per liter (pCi/L), respectively, of tritium. Background tritium activity levels in SNL/NM soils were not evaluated as part of the SNL/NM background study completed in March 1996 (IT March 1996). No uranium isotopes were detected above the background UTL or 95th percentile concentrations presented in the SNL/NM study of naturally-occurring constituents. In addition, the screening of the soil samples by gamma spectroscopy did not identify any other anthropogenic or naturally occurring radionuclides above SNL/NM background levels (IT March 1996).

3.2.8 Quality Assurance/Quality Control Summary

Quality assurance/quality control (QA/QC) samples collected during this effort consisted of two sets of duplicate soil samples from the north and west drainfields, one set of aqueous

equipment rinsate blank samples, and two soil trip blanks. The duplicate soil samples consisted of material from (1) the shallow interval in the north drainfield borehole DF3-6 and (2) the shallow interval in the west drainfield borehole DF1-5 (Figure 1-2). The duplicate samples were analyzed for VOCs, SVOCs, RCRA metals, and three isotopic uranium radionuclides. Concentrations of the organic, inorganic, and isotopic uranium constituents detected in the two sets of duplicate soil samples were for the most part in good agreement with those detected in the equivalent field samples from the same two sampling intervals.

Trace concentrations of one laboratory-introduced VOC (methylene chloride), lead, and two uranium isotopes were detected in the equipment rinsate samples. Also, two soil trip blanks were included with the two shipments of soil samples to the commercial laboratory in January 1995, and were analyzed for VOCs only. A number of common VOC laboratory contaminants were detected in the trip blanks. These common laboratory contaminants were either not detected, or were for the most part found in lower concentrations in the soil characterization samples compared to the trip blanks. Soil used for the trip blanks was prepared by heating the material, and then transferring it immediately to the sample container. This heating process drives off any residual organic compounds (if present), and soil moisture, that may be contained in the material. It is thought that when the soil trip blank container was opened at the laboratory, it immediately adsorbed both moisture and VOCs present in the laboratory atmosphere, and therefore became slightly contaminated.

Analytical data summary tables of organic, inorganic, and radionuclide constituents analyzed for and detected in the 1994 and 1995 ER Site 147 confirmatory soil and associated QA samples are presented in Section 6.4. Results of the SNL/NM in-house gamma spectroscopy screening of the composite soil samples from the three drainfields are presented in Sections 6.5 through 6.10. Complete soil sample analytical data packages for samples collected in 1994 and 1995 are archived in the SNL/NM Environmental Safety and Health (ES&H) Records Center and are available for review and verification (SNL/NM January 1995c).

3.3 Gaps in Information

The most recent material present in the north and west system septic tanks was not necessarily representative of all discharges to the units that occurred since they were put into service starting in 1959. The analytical results of the various rounds of septic tank sampling were used, along with process knowledge and other available information, to help identify the most likely COCs that might be found in soils next to the three septic tanks and beneath the three drainfields, and to select the types of analyses to be performed on soil samples collected from the site. While the history of past releases at the site is incomplete, analytical data from confirmatory soil samples collected in January 1995 (Section 3.2.7) and subsequent risk assessment (Section 3.4) are sufficient to determine whether significant releases of COCs occurred at the site.

3.4 Risk Evaluation

The following subsections summarize the results of the risk assessment analysis for both human and ecological risk-related factors. A complete discussion of the risk assessment process, assumptions, uncertainties, and results is provided in Section 6.11.

3.4.1 Human Risk Analysis

ER Site 147 has been recommended for industrial land-use (DOE 1996). Due to the presence of several metals and tritium in a few samples at concentrations slightly greater than the SNL/NM 95th percentile, UTL background levels, or detection levels, it was necessary to perform a human health risk assessment analysis for the site. Because explosives residue is a COC for the site, it was included in the risk assessment at the detection limit even though no concentrations were detected. The risk assessment process results in a quantitative evaluation of the potential adverse human health effects caused by constituents in the site's soil. The risk assessment report calculated the hazard index and excess cancer risk for both an industrial land-use and residential land-use setting.

In summary, the hazard index calculated for chemical compounds is 0.03, and the incremental hazard index is 0.01 for an industrial land-use setting, which is much less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). The excess cancer risk for chemical compounds is estimated to be 4×10^{-6}, but there is no incremental excess cancer risk for an industrial land-use setting. This excess cancer risk is at the low end of the suggested range of acceptable risk of 10^{-6} and 10^{-4} (EPA 1989). The excess cancer risk for radionuclides is 5×10^{-10} for the industrial land-use scenario, which is much less than risk values calculated due to naturally occurring radiation and from intakes considered background concentrations values. In addition, the estimated effective dose equivalent for an industrial land-use setting is 1×10^{-5} millirem per year (mrem/year); this value is well below the standard dose limit of 15 mrem/year (40 CFR 196, 1994).

The residential land-use scenario for this site is provided only for comparison in the risk assessment analysis in Section 6.11. The risk assessment analysis in Section 6.11 concludes that ER Site 147 does not have significant potential to affect human health under an industrial land-use scenario.

3.4.2 Ecological Risk Analysis

It is unlikely that the COCs at ER Site 147 will have much impact on ecological risk. Much of the relevant ecological information for ER Site 147 can be found in the National Environmental Policy Act (NEPA) compliance document (SNL/NM 1992). Ecological risk has not been addressed in this NFA proposal because the ecological risk analysis for ER Site 147 has not been estimated at this time. Ecological risk analyses are being conducted for SNL/NM ER sites, and the relevant analysis for this site will be presented when available. However, because the drainlines for the septic systems at this site, which are the release points of effluent from the systems, are greater than 5 ft bgs, it is highly unlikely that there is any potential for ecological risk at this site.

4.0 RATIONALE FOR NO FURTHER ACTION DECISION

ER Site 147 is being proposed for an NFA determination for the following reasons:

- As discussed in Section 3.2.6, the PETREX™ passive soil-gas survey identified a number of locations with VOCs in soil gas at potentially detectable concentrations in soil samples. However, confirmatory soil sampling around the three septic tanks and in the three drainfields identified only low to trace concentrations of six VOC compounds (which are common laboratory contaminants) in soil samples collected from this site.

- As discussed in Section 3.4 above, no concentration of any of the RCRA metals detected at this site poses a significant risk to human health or the environment. Also, below-reporting-limit concentrations of only three SVOCs were detected, and TNT was not identified in any of the soil samples using a TNT immunoassay screening technique. Activity levels of the three uranium isotopes detected in samples were in all cases less than the respective 95th percentile background concentrations of those radionuclides in SNL/NM soils. Also, the highest tritium activity level of 450 pCi/L detected at the site has been demonstrated to pose an insignificant level of risk, and the gamma spectroscopy screening of samples from the three drainfields did not indicate significant concentrations of other radionuclides in soils at this site (Sections 6.5 through 6.10).

- Finally, the ER Site 147 north and west system septic tank contents were removed, and the tanks were thoroughly cleaned and decontaminated in January 1996 (SNL/NM January 1996a). The photograph in Figure 4-1 shows the north tank being steam cleaned following removal of septage from the unit. The empty and decontaminated tanks then were inspected by a representative of the New Mexico Environment Department (NMED) to verify that the tank contents had been removed and the tanks closed in accordance with applicable State of New Mexico regulations (SNL/NM January 1996c). As a final measure, samples of the cleaned and decontaminated concrete from the bottoms of both the north and west system tanks were collected for waste characterization purposes and to verify that significant levels of radionuclides were not entrained in the material. Background tank concrete samples were also collected from the exterior of each tank, for comparison to the bottom samples (SNL/NM January 1996b, January 1996d, February 1996, and March 1996b). The tank bottom and background concrete samples were analyzed for three isotopic uranium radionuclides by a commercial laboratory, and were also screened for additional radionuclides using SNL/NM in-house gamma spectroscopy. Significant levels of radionuclides were not detected in any of these concrete samples (SNL/NM March 1996c).

Sample analytical results generated from this confirmatory sampling investigation have shown that detectable or significant concentrations of COCs are not present in soils at ER Site 147, and that additional investigations are unwarranted and unnecessary. Based on archival information, chemical and radiological analytical results of soil samples collected next to the septic tanks and in the drainfields, and human health risk assessment analysis, SNL/NM has demonstrated that COCs that may have been released from this site into the environment pose an acceptable level of risk under current and projected future land-use (DOU NFA Criterion 5), and the site does not

Cleaning the north system septic tank walls with a steam cleaner following removal of sludge from the unit. January 5, 1996. View looking northeast.

Figure 4-1. ER Site 147 Photographs, concluded:

5.0 REFERENCES

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6.0 ANNEXES

6.1 Summary of Constituents in the 1992 Septic Tank Septage Samples

Note: The text and tables included in Section 6.1 have been taken directly from the Sandia National Laboratories/New Mexico Septic Tank Monitoring Program, 1992 Report" (SNL/NM June 1993), and have not been altered from their original form. The introductory text for the Building 9925 septic tank sampling states that "On July 16, 1992, aqueous and sludge samples were collected from the inactive septic tank and seepage pit serving Building 9925." There is no seepage pit associated with any of the three Building 9925 septic systems. Apparently the north system septic tank was mistaken for a seepage pit by personnel collecting the samples in 1992. Also, the first bullet in the summary is misstated: The 1.7 mg/L of TCE does not exceed the City of Albuquerque discharge limit of 5.0 mg/L.

6.2 Summary of Constituents in the 1994 and 1995 West and North Septic Tank Septage Samples

6.3 Summary of 1994 PETREX™ Passive Soil-Gas Survey Results

6.4 1995 Confirmatory Sample Analytical Data Summary Tables

6.5 Gamma Spectroscopy Screening Results for the Shallow Interval Composite Soil Sample From the North Drainfield

6.6 Gamma Spectroscopy Screening Results for the Deep Interval Composite Soil Sample From the North Drainfield

6.7 Gamma Spectroscopy Screening Results for the Shallow Interval Composite Soil Sample From the West Drainfield

6.8 Gamma Spectroscopy Screening Results for the Deep Interval Composite Soil Sample From the West Drainfield

6.9 Gamma Spectroscopy Screening Results for the Shallow Interval Composite Soil Sample From the South Drainfield

6.10 Gamma Spectroscopy Screening Results for the Deep Interval Composite Soil Sample From the South Drainfield

ER Site 147
Summary of Constituents in the 1992 Septic Tank Septage Samples

Building 9925
Coyote Test Field
Sample ID No. SNLA008426
Tank ID No. AD89039R

On July 16, 1992, aqueous and sludge samples were collected from the inactive septic tank and seepage pit serving Building 9925. Analytical results of concern are noted below.

- Trichloroethene (TCE) was detected in the aqueous sample at a level of 1.7 mg/L, which exceeds the New Mexico Water Quality Act discharge limit (NMDL) of 0.1 mg/L, the City of Albuquerque (COA) discharge limit of 5.0 mg/L, and the Resource Conservation and Recovery Act (RCRA) toxicity characteristic (TC) limit of 0.5 mg/L.

- Cadmium was detected in the aqueous sample at a level of 0.014 mg/L, which exceeds the NMDL of 0.01 mg/L.

- Copper was detected in the aqueous sample at a level of 1.4 mg/L, which exceeds the NMDL of 1.0 mg/L.

- Lead was detected in the aqueous sample at a level of 0.074 mg/L, which exceed the NMDL of 0.05 mg/L.

- Total phenolic compounds were detected in the aqueous sample at a level of 0.012 mg/L, which exceeds the NMDL of 0.005 mg/L.

No other parameters were detected in the aqueous sample above NMDLs, COA discharge limits, or RCRA TC limits that identify characteristic hazardous waste.

Laboratory control samples for total phenolic compounds were out of laboratory control limits (no analyte was detected), but the analyses were not repeated. The analytical data for phenolics is, therefore, qualified.

During review of the radiochemistry sludge data, the following item was noted:

- ^{226}Ra, measured at 0.645 pCi/mL by gamma spectroscopy, does not exceed the IL calculated during this monitoring effort. However, this finding exceeds U.S. Department of Energy derived concentration guideline limit of 0.5 pCi/mL. ^{226}Ra was measured in the aqueous sample at 0.0007 pCi/mL.

ER Site 147
Summary of Constituents in the 1992 Septic Tank Septage Samples

Results of Septic Tank Analyses
(LIQUID SAMPLES)

Building No./Area:	9925 CTF
Tank ID No.:	AD89039R
Date Sampled:	7/16/92
Sample ID No.:	SNLA-008426

Analytical Parameter	Measured Concentration	State Discharge Limit	COA Discharge Limit	Comments
Volatile Organics (EPA 624)	(mg/l)	(mg/l)	(mg/l)	
Trichloroethene	1.7	0.1	(TTO=5.0)	Exceeds State Limit; Exceeds RCRA TC limit of 0.5 mg/L
Semivolatile Organics (EPA 625)	(mg/l)	(mg/l)	(mg/l)	
None detected above laboratory		Parameter	(TTO=5.0)	
reporting limits		Specific		
Pesticides (EPA 608)	(mg/l)	(mg/l)	(mg/l)	
None detected above laboratory		NR	(TTO=5.0)	
reporting limits				
PCBs (EPA 608)	(mg/l)	(mg/l)	(mg/l)	
None detected above laboratory		0.001	(TTO=5.0)	
reporting limits				
Metals	(mg/l)	(mg/l)	(mg/l)	
Arsenic	0.0085	0.1	2.0	
Barium	0.78	1.0	20.0	
Cadmium	0.014	0.01	2.8	Exceeds State Limit
Chromium	0.029	0.05	20.0	
Copper	1.4	1.0	16.5	Exceeds State Limit
Lead	0.074	0.05	3.2	Exceeds State Limit
Manganese	0.18	0.20	20.0	
Mercury	0.0011	0.002	0.1	
Nickel	---	NR	12.0	Not analyzed
Selenium	ND (0.010)	0.05	2.0	
Silver	ND (0.010)	0.05	5.0	
Thallium	ND (0.010)	NR	NR	
Zinc	3.2	10.0	28.0	
Uranium	0.01	5.0	NR	
Miscellaneous Analytes	(mg/l)	(mg/l)	(mg/l)	
Phenolic Compounds	0.012	0.005	4.0	Exceeds State Limit
Nitrates/Nitrites	1.7	10.0	NR	
Formaldehyde	0.85	NR	260.0	
Fluoride	0.47	1.6	180.0	
Cyanide	0.061	0.2	8.0	
Oil and Grease	2.3	NR	150.0	
Radiological Analyses	(pCi/l)	(pCi/l)	(pCi/l)	
Radium 226	0.7 +/- 0.1	30.0	NR	
Radium 228	0 +/- 30	30.0	NR	
Gross Alpha	30 +/- 20	NR	NR	
Gross Beta	60 +/- 50	NR	NR	
Tritium	-190 +/- 595	NR	NR	

NR = Not Regulated; ND(#.#) = Not Detected (Reporting Limit); TC = Toxicity Characteristic of Hazardous Waste

Note: City and State Discharge Limits are for comparison purposes only. City limits apply to discharge of sanitary effluent and not septic tank waste; state limits apply to effluent discharged onto or below the surface of the ground.

References - City of Albuquerque NM Sewer Use and Wastewater Control Ordinance (1990), Section 8-9-3; and New Mexico Water Quality Control Commission Regulations (1988), Section 3-100

ER Site 147
Summary of Constituents in the 1992 Septic Tank Septage Samples

Results of Septic Tank Analyses (Sludge Sample)			
Building No./Area:	**9925 CTF**		
Tank ID No.:	**AD89039R**		
Date Sampled:	**7/16/92**		
Sample ID No.:	**SNLA008426**		
Analytical Parameter	**Measured Concentration**	**± 2 Sigma Uncertainty**	**Units**
Water Content	92.20	NA	%
Arsenic	1.6	NA	mg/kg
Barium	41.8	NA	mg/kg
Cadmium	4.0	NA	mg/kg
Chromium	4.9	NA	mg/kg
Copper	441	NA	mg/kg
Lead	26.8	NA	mg/kg
Manganese	10.4	NA	mg/kg
Mercury	0.78	NA	mg/kg
Nickel	---	NA	mg/kg
Selenium	0.90	NA	mg/kg
Silver	ND(1.0)	NA	mg/kg
Thallium	ND(0.5)	NA	mg/kg
Zinc	447	NA	mg/kg
Gross Alpha	27	15	pCi/g
Gross Beta	28	25	pCi/g
Gross Alpha	7	12	pCi/g
Gross Beta	31	26	pCi/g
Gross Alpha	19	14	pCi/g
Gross Beta	30	24	pCi/g
Gross Alpha	24	14	pCi/g
Gross Beta	28	22	pCi/g
Tritium	-190	595	pCi/L
Bismuth-214	0.0612	0.00914	pCi/mL
Cesium-137	0.0112	0.00310	pCi/mL
Potassium-40	0.522	0.0719	pCi/mL
Lead-212	0.0403	0.00509	pCi/mL
Lead-214	0.0528	0.00768	pCi/mL
Radium-226	0.645	0.0795	pCi/mL
Thorium-234	<0.172	NA	pCi/mL
Thallium-208	0.0170	0.00381	pCi/mL

ND = Not Detected
NA = Not Applicable

ER Site 147
Summary of Constituents in 1994 and 1995 West and North Septic Tank Samples

Sample Number	Sample Type	Sample Date	Sample Matrix	Method	Compound Name	Result	Reporting Limit or M.D.A.	Error *	Units
WEST SYSTEM SEPTIC TANK SAMPLES:									
May 1994 Samples:									
015466-8	Grab	5/9/94	Sludge	8240 (VOCs)	2-Butanone	0.41 B,J	1.00	NR	mg/kg
					Methylene Chloride	0.37 B,J	0.50	NR	mg/kg
015466-7	Grab	5/9/94	Sludge	8270 (SVOCs)	1,2-Dichlorobenzene	0.28 J	0.33	NR	mg/kg
					2-Methylnaphthalene	0.10 J	0.33	NR	mg/kg
					Bis(2-Ethylhexyl) Phthalate	2.70 J	0.33	NR	mg/kg
					Di-N-Butyl Phthalate	0.036 J	0.33	NR	mg/kg
					Fluoranthene	0.075 J	0.33	NR	mg/kg
					Phenanthrene	0.092 J	0.33	NR	mg/kg
					Pyrene	0.042 J	0.33	NR	mg/kg
015466-3	Grab	5/9/94	Liquid	9065	Phenolic compounds	ND	0.01	NR	mg/L
015466-6	Grab	5/9/94	Sludge	9065	Phenolic compounds	1 J	3.8	NR	mg/kg
015466-2	Grab	5/9/94	Liquid	Total Metals (6010)	Arsenic	0.0045 J	0.01	NR	mg/L
				Total Metals (6010)	Barium	0.031	0.01	NR	mg/L
				Total Metals (6010)	Cadmium	ND	0.005	NR	mg/L
				Total Metals (6010)	Chromium	ND	0.01	NR	mg/L
				Total Metals (6010)	Lead	ND	0.003	NR	mg/L
				Total Metals (7470)	Mercury	ND	0.0002	NR	mg/L
				Total Metals (6010)	Selenium	ND	0.013	NR	mg/L
				Total Metals (6010)	Silver	0.0052 J	0.01	NR	mg/L
015466-4	Grab	5/9/94	Sludge	TCLP/6010	Arsenic	ND	0.1	NR	mg/L
				TCLP/6010	Barium	0.76 B	0.01	NR	mg/L
				TCLP/6010	Cadmium	ND	0.005	NR	mg/L
				TCLP/6010	Chromium	ND	0.01	NR	mg/L
				TCLP/6010	Lead	ND	0.05	NR	mg/L
				TCLP/7470	Mercury	ND	0.0004	NR	mg/L
				TCLP/6010	Selenium	ND	0.012	NR	mg/L
				TCLP/6010	Silver	ND	0.01	NR	mg/L
015466-5	Grab	5/9/94	Sludge	8330	14 Explosive compounds	ND	1.4-13	NR	ug/kg
015466-10	Grab	5/9/94	Liquid	HASL-300	Uranium-233/234	ND	4.3	0.5	pCi/L
				(Isotopic uranium)	Uranium-235	ND	0.087	0.046	pCi/L
					Uranium-238	ND	2.1	0.29	pCi/L
015466-9	Grab	5/9/94	Liquid	EPA H-01	Tritium	ND	380	170	pCi/L
015466-11	Grab	5/9/94	Liquid	Gamma Spec.	70 Radionuclides	ND	0.0079-17.4	NR	pCi/g

ER Site 147
Summary of Constituents in 1994 and 1995 East and West Septic Tank Samples

Sample Number	Sample Type	Sample Date	Sample Matrix	Method	Compound Name	Result	Reporting Limit or M.D.A.	Error *	Units
WEST SYSTEM SEPTIC TANK SAMPLES, continued:									
015466-12	Grab	5/9/94	Sludge	Gamma spec.	*Uranium Series:*				
					Radium-226	0.602	NR	0.329	pCi/g
					Thorium series:				
					Thorium-232	0.0679	NR	0.051	pCi/g
					Radium-228	0.0679	NR	0.051	pCi/g
					Thorium-228	0.0796	NR	0.039	pCi/g
					Lead-212	0.0799	NR	0.039	pCi/g
					Other radionuclides:				
					Cesium-137	0.0172	NR	0.014	pCi/g
					Potassium-40	0.826	NR	0.216	pCi/g
January 1995 Sample:									
021476-4	Grab	1/25/95	Sludge	HASL-300	Uranium-234	4.4	0.013	0.55	pCi/g
				(Isotopic uranium)	Uranium-235	0.098	0.029	0.045	pCi/g
					Uranium-238	3	0.029	0.39	pCi/g
NORTH SYSTEM SEPTIC TANK SAMPLES:									
021473-10	Grab	1/25/95	Sludge	8240 (VOCs)	2-Butanone	10	10	NR	ug/kg
					Acetone	58	10	NR	ug/kg
					Benzene, Methyl-	9.9	5	NR	ug/kg
					Carbon Disulfide	1.6 J	5	NR	ug/kg
					Methylene Chloride	1.7 J	5	NR	ug/kg
021474-9	Dupl.	1/25/95	Sludge	8240 (VOCs)	2-Butanone	7.2 J	10	NR	ug/kg
					Acetone	36	10	NR	ug/kg
					Benzene, Methyl-	8.2	5	NR	ug/kg
					Carbon Disulfide	1.6 J	5	NR	ug/kg
					Methylene Chloride	1.8 J	5	NR	ug/kg
021473-3	Grab	1/25/95	Liquid	8270 (SVOCs)	Multiple SVOC compounds	ND	10,20, or 50	NR	ug/L
021474-2	Dupl.	1/25/95	Liquid	8270 (SVOCs)	Multiple SVOC compounds	ND	10,20, or 50	NR	ug/L
021473-11	Grab	1/25/95	Sludge	8270 (SVOCs)	Bis(2-Ethylhexyl) Phthalate	640 J	1,400	NR	ug/kg
021474-10	Dupl.	1/25/95	Sludge	8270 (SVOCs)	Bis(2-Ethylhexyl) Phthalate	4,300	990	NR	ug/kg
021473-6	Grab	1/25/95	Liquid	8330	14 Explosive compounds	ND	0.02-0.84	NR	ug/L
021474-5	Dupl.	1/25/95	Liquid	8330	14 Explosive compounds	ND	0.02-0.84	NR	ug/L

Section 6.2, continued:

ER Site 147
Summary of Constituents in 1994 and 1995 East and West Septic Tank Samples

Sample Number	Sample Type	Sample Date	Sample Matrix	Method	Compound Name	Result	Reporting Limit or M.D.A.	Error *	Units
NORTH SYSTEM SEPTIC TANK SAMPLES, continued:									
021473-4	Grab	1/25/95	Liquid	Total Metals/6010	Arsenic	ND	0.01	NR	mg/L
				Total Metals/6010	Barium	0.096	0.01	NR	mg/L
				Total Metals/6010	Cadmium	ND	0.005	NR	mg/L
				Total Metals/6010	Chromium	ND	0.01	NR	mg/L
				Total Metals/6010	Lead	0.011	0.003	NR	mg/L
				Total Metals/6010	Selenium	ND	0.0065	NR	mg/L
				Total Metals/6010	Silver	ND	0.01	NR	mg/L
021473-5	Grab	1/25/95	Liquid	Total Metals/7470	Mercury	ND	0.0002	NR	mg/L
021474-3	Dupl.	1/25/95	Liquid	Total Metals/6010	Arsenic	ND	0.01	NR	mg/L
				Total Metals/6010	Barium	0.059	0.01	NR	mg/L
				Total Metals/6010	Cadmium	ND	0.005	NR	mg/L
				Total Metals/6010	Chromium	ND	0.01	NR	mg/L
				Total Metals/6010	Lead	0.0041	0.003	NR	mg/L
				Total Metals/6010	Selenium	ND	0.0063	NR	mg/L
				Total Metals/6010	Silver	ND	0.01	NR	mg/L
021474-4	Dupl.	1/25/95	Liquid	Total Metals/7470	Mercury	ND	0.0002	NR	mg/L
021473-11	Grab	1/25/95	Sludge	Total Metals/6010	Arsenic	2.5	1	NR	mg/kg
				Total Metals/6010	Barium	86.8	1	NR	mg/kg
				Total Metals/6010	Cadmium	1.3	0.5	NR	mg/kg
				Total Metals/6010	Chromium	6.4	1	NR	mg/kg
				Total Metals/6010	Lead	10.6	5	NR	mg/kg
				Total Metals/7470	Mercury	0.21	0.1	NR	mg/kg
				Total Metals/6010	Selenium	1.2	0.5	NR	mg/kg
				Total Metals/6010	Silver	ND	1	NR	mg/kg
021474-10	Dupl.	1/25/95	Sludge	Total metals (6010)	Arsenic	2.6	1	NR	mg/kg
				Total metals (6010)	Barium	88.4	1	NR	mg/kg
				Total metals (6010)	Cadmium	1.9	0.5	NR	mg/kg
				Total metals (6010)	Chromium	6.2	1	NR	mg/kg
				Total metals (6010)	Lead	11.7	5	NR	mg/kg
				Total metals (7471)	Mercury	0.28	0.1	NR	mg/kg
				Total metals (6010)	Selenium	2.3	0.5	NR	mg/kg
				Total metals (6010)	Silver	ND	1	NR	mg/kg
021473-8	Grab	1/25/95	Liquid	HASL-300	Uranium-234	2.5 B	0.044	0.37	pCi/L
				(Isotopic uranium)	Uranium-235	ND	0.066	0.048	pCi/L
					Uranium-238	1.3 B	0.06	0.24	pCi/L
021474-7	Dupl.	1/25/95	Liquid	HASL-300	Uranium-234	2.6 B	0.065	0.44	pCi/L
				(Isotopic uranium)	Uranium-235	0.044	0.029	0.044	pCi/L
					Uranium-238	1.7 B	0.065	0.33	pCi/L

Section 6.2, concluded:

ER Site 147
Summary of Constituents in 1994 and 1995 East and West Septic Tank Samples

Sample Number	Sample Type	Sample Date	Sample Matrix	Method	Compound Name	Result	Reporting Limit or M.D.A.	Error *	Units
NORTH SYSTEM SEPTIC TANK SAMPLES, concluded:									
021473-12	Grab	1/25/95	Sludge	HASL-300	Uranium-234	29	0.037	3.1	pCi/g
				(Isotopic uranium)	Uranium-235	0.89	0.029	0.15	pCi/g
					Uranium-238	16	0.029	1.7	pCi/g
021474-11	Dupl.	1/25/95	Sludge	HASL-300	Uranium-234	27	0.026	2.9	pCi/g
				(Isotopic uranium)	Uranium-235	0.6	0.036	0.12	pCi/g
					Uranium-238	14	0.026	1.6	pCi/g
021473-15	Grab	1/25/95	Liquid	EPA-600 906.0	Tritium	ND	240	140	pCi/L
021474-13	Grab	1/25/95	Sludge	Gamma spec.	*Uranium Series:*				
					Thorium-234	9.3	3.7	2.5	pCi/g
					Radium-226	1.1	0.96	0.65	pCi/g
					Lead-214	1.5	0.72	0.5	pCi/g
					Bismuth-214	1.1	0.99	0.67	pCi/g
					Thorium Series:				
					Radium-228	3	1.8	1.3	pCi/g
					Actinium-228	3	1.8	1.3	pCi/g
					Thorium-228	2.3	1.1	0.82	pCi/g
					Lead-212	1.1	0.6	0.4	pCi/g
					Thallium-208	2.2	1	0.76	pCi/g
					Actinium Series:				
					Uranium-235	0.49	0.43	0.27	pCi/g
					Other Radionuclides:				
					Potassium-40	10	7.4	5.9	pCi/g
August 1995 Sample:									
025087-00	Grab	8/17/95	Liquid	8240 (VOCs)	Multiple VOC compounds	ND	0.5 - 5	NR	ug/L

Notes

B = Compound detected in asociated blank sample
J = Result is detected below the reporting limit or is an estimated concentration.
M.D.A. = Minimum detectable activity
mg/kg = Milligrams per kilogram
mg/L = Milligrams per liter
ND = Not d+R[-176]Cetected
NR = Not reported by laboratory
pCi/g = Picocuries per gram
pCi/L = Picocuries per liter
Spec. = spectroscopy
SVOCs = Semivolatile organic compounds
TCLP = Toxicity Characteristic Leaching Procedure
ug/kg = Micrograms per kilogram
ug/L = micrograms per liter
VOCs = Volatile organic compounds
* Error = plus or minus 2 sigma uncertainty

ER Site 147
Summary of 1994 PETREX™ Passive Soil-Gas Survey Results
for a Portion of the North System, and all of the West System

PETREX Relative Soil Gas Response Values
(in ion counts)
STD SITE 147

	Sample	PCE	TCE	BTEX	Aliphatics
Phase I Sampling					
	85	111270	ND	6714690	2127332
	86	10160	ND	3435438	516334
	87	42766	ND	34840	84939
	88	ND	ND	ND	1008
	89	ND	ND	24323	19507
	90	8689	ND	20228	14104
	91	51240	ND	150081	118624
	92	ND	ND	ND	ND
	93	16912	ND	238500	95907
	94	3386	ND	38925	17209
	95	49943	1901	75605	507326
	97	35848	ND	269602	70207
	98	ND	ND	2214	830
	99	64721	ND	188942	553324
	100	41699	ND	10720	11299
	101	124381	30248	2793727	423533
	102	ND	ND	136825	28551
	103	ND	ND	897	11384
	104	ND	ND	ND	ND
	105	5440	ND	80637	7034
	106	ND	2300	985268	2165901
	107	ND	ND	50578	33994
	108	1265	ND	ND	ND
	D-1098	8307	ND	139849	52756
	D-1099	57510	ND	186008	440821
	D-1103	ND	ND	ND	6195
	D-1106	989	4537	756085	3266118
	* 139	ND	ND	5334	10013
	* 140	ND	ND	ND	2593
Phase II Sampling					
	555	ND	ND	1,384	3,652
	556	ND	ND	12,238	5,983
	557	ND	ND	3,206	904
	558	ND	ND	628	1,170
	559	ND	ND	14,650	13,140
	560	ND	ND	8,898	5,737
	561	ND	ND	619	979

ER Site 147
Summary of 1994 PETREX™ Passive Soil-Gas Survey Results
for the South System

PETREX Relative Soil Gas Response Values
(in ion counts)
STD SITE 147S

Sample	PCE	TCE	BTEX	Aliphatics
73	ND	ND	ND	ND
74	971	ND	9832	15918
75	ND	ND	3616	853
76	1128	ND	39326	25599
77	80659	ND	1265895	2129249
78	6736	ND	31276	57675
79	31313	ND	462835	606154
80	85083	20569	785766	2161458
81	134059	13193	5497832	3894289
82	53089	ND	325814	461080
83	85678	1402	139325	221000
84	303106	ND	2009964	5119333
D-1074	ND	ND	1150	953
* 139	ND	ND	5334	10013
* 140	ND	ND	ND	2593

PCE- Tetrachloroethene
Indicator Mass Peak(s) 164

TCE - Trichloroethene
Indicator Mass Peak(s) 130

BTEX-Benzene, Toluene, Ethylbenzene/Xylene(s)
Indicator Mass Peak(s) 78, 92, 106

Aliphatics - C4-C11 Cycloalkanes/alkenes
Indicator Mass Peak(s) 56, 70, 84, 98, 112,
126, 140, 154

D - Duplicate Sample
Sample numbers in thousands duplicate of sample numbers in hundreds

* QA/QC Blank Sample - No Compounds Detected
above the PETREX Normal reporting Limits

ER Site 147
Summary of 1994 PETREX™ Passive Soil-Gas Survey Results
for a Portion of the North System Drainfield

PETREX Relative Soil Gas Response Values
(in ion counts)
STD SITE 147

Sample	PCE	TCE	BTEX	Aliphatics
562	ND	ND	28,485	1,357,156
563	ND	ND	1,355	9,838
564	ND	ND	3,259	2,503
566	ND	ND	5,240	11,707
567	ND	ND	318,770	35,526
568	ND	ND	12,530	6,396
569	2,161	ND	1,961	ND
570	ND	ND	5,726	1,990
571	ND	ND	8,220	1,043
572	ND	ND	22,952	17,236
573	ND	ND	2,782	1,890
D-2567	ND	ND	165,378	21,272
D- 2569	7,940	680	20,233	5,353
* 900	ND	ND	ND	ND
* 901	ND	ND	ND	ND

PCE- Tetrachloroethene
Indicator Mass Peak(s) 164

TCE - Trichloroethene
Indicator Mass Peak(s) 130

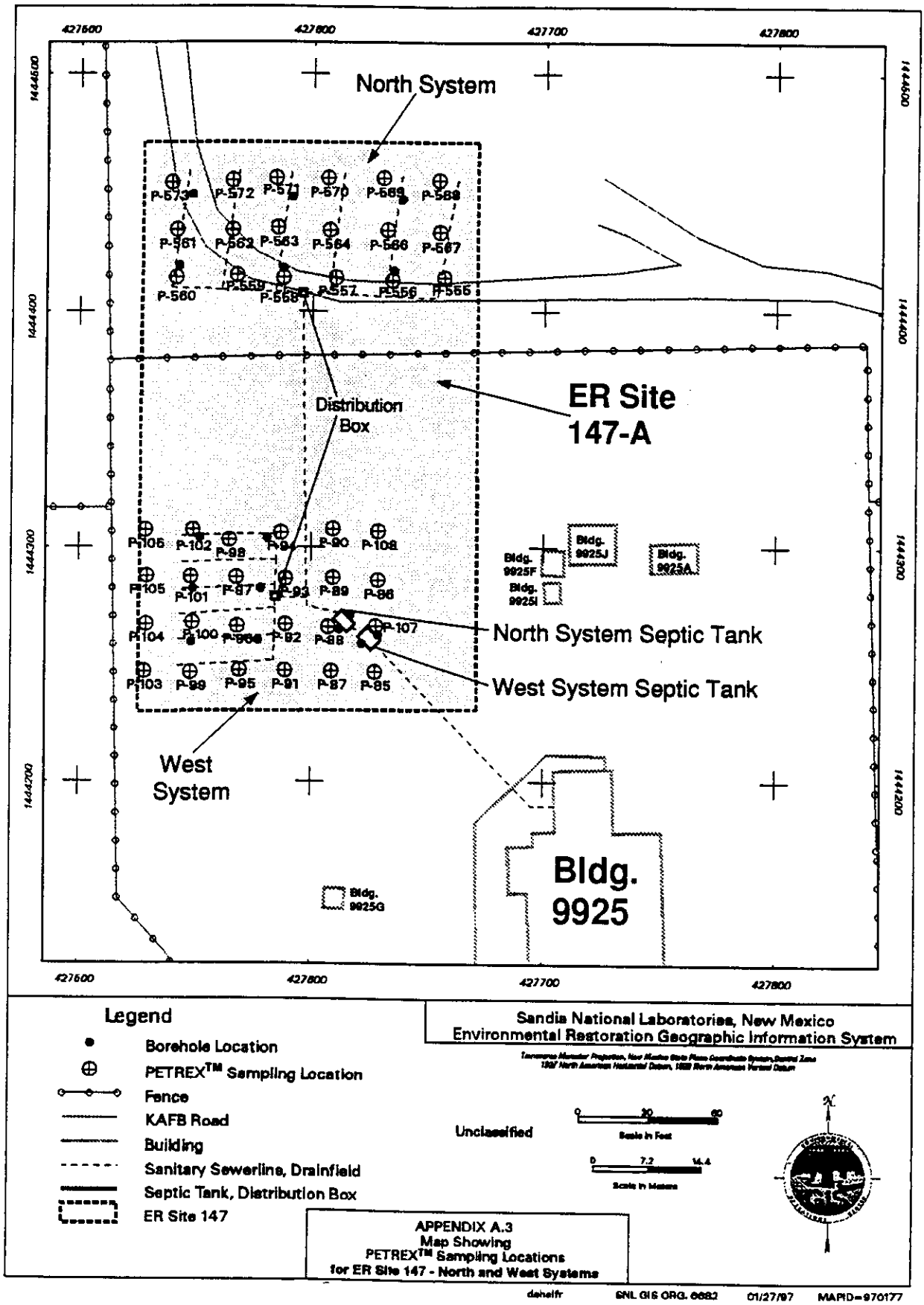
BTEX-Benzene, Toluene, Ethylbenzene/Xylene(s)
Indicator Mass Peak(s) 78, 92, 106

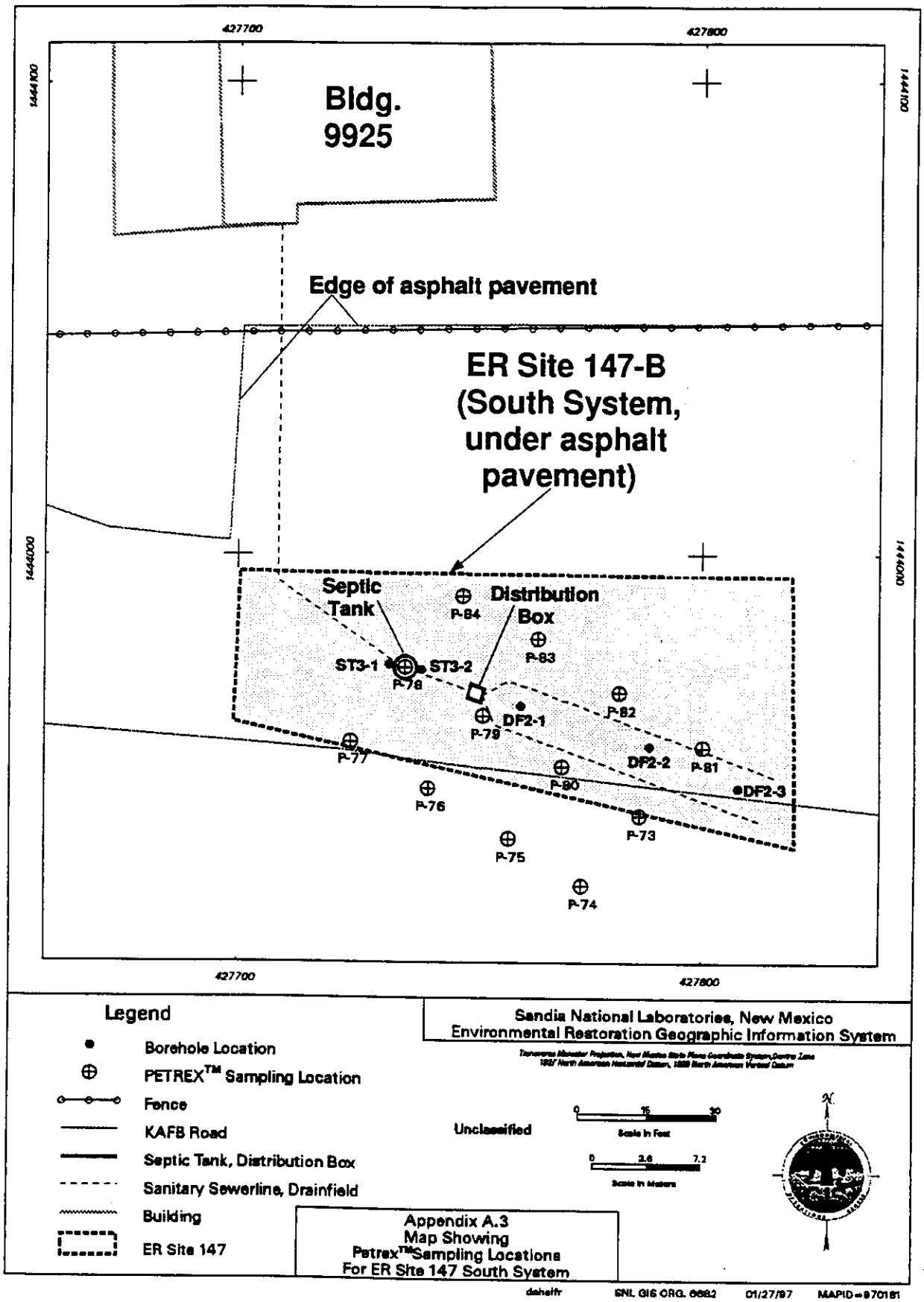
Aliphatics - C4-C11 Cycloalkanes/alkenes
Indicator Mass Peak(s) 56, 70, 84, 98, 112,
126, 140, 154

D - Duplicate Sample
Sample numbers in thousands duplicate of sample numbers in hundreds

* QA/QC Blank Sample - No Compounds Detected
above the PETREX Normal reporting Limits

Section 6.3, continued:




427700
427800
1444100
1444000
Bldg.
9925
Edge of asphalt pavement
ER Site 147-B
(South System,
under asphalt
pavement)
Septic
Tank
Distribution
Box
P-84
P-83
ST3-1
ST3-2
P-78
P-82
DF2-1
P-79
P-77
DF2-2
P-81
P-80
DF2-3
P-76
P-73
P-75
P-74
Legend
Borehole Location
PETREX™ Sampling Location
Fence
KAFB Road
Septic Tank, Distribution Box
Sanitary Sewerline, Drainfield
Building
ER Site 147
Sandia National Laboratories, New Mexico
Environmental Restoration Geographic Information System
Unclassified
Scale in Feet
Scale in Meters
N
Appendix A.3
Map Showing
Petrex™ Sampling Locations
For ER Site 147 South System
dshelfr
SNL GIS ORG. 6582
01/27/97
MAPID=970181

Section 6.4

ER Site 147
Summary of Organic Constituents in Confirmatory Soil Samples
Collected in the Three Drainfields and Around the Three Septic Tanks

Sample Number	Sample Matrix	Sample Type	Sample Date	Sample Location (Figures 1-2 or 1-3)	Top of Sample Interval (fbgs)	VOCs Method 8240									SVOCs Method 8270			TNT Screen Colorimetric Method Based on EPA 8515	Units
						Acetone	Ethyl-Benz.	2-Hexa-none	MEK	MIBK	Meth. Chloride	PCE	Toluene	Total Xylenes	BEHP	DNBP	Phenol		
North Septic Tank Soil Samples:																			
018876-1,2	Soil	Field	1/4/95	ST2-1	9	6.8 J	ND	ND	ND	ND	2.4 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018877-1,2	Soil	Field	1/4/95	ST2-2	9	17	ND	ND	ND	2.5 J	1.9 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
North Drainfield Soil and QA Samples:																			
018894-1,2	Soil	Field	1/10/95	DF3-1	9	ND	ND	ND	ND	ND	2.4 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018895-1,2	Soil	Field	1/10/95	DF3-1	19	ND	ND	ND	ND	ND	2.8 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018896-1,2	Soil	Field	1/10/95	DF3-2	9	ND	ND	ND	ND	ND	2.4 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018897-1,2	Soil	Field	1/10/95	DF3-2	19	4.6 J	ND	ND	ND	ND	2.5 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018892-1,2	Soil	Field	1/9/95	DF3-3	9	ND	ND	ND	ND	ND	2.9 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018893-1,2	Soil	Field	1/9/95	DF3-3	19	ND	ND	ND	ND	ND	2.3 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018891-1,2	Soil	Field	1/9/95	DF3-4	9	11	ND	ND	ND	2J	2.6 B,J	ND	ND	ND	ND	44 J	ND	ND	ug/kg
018898-1,2	Soil	Field	1/10/95	DF3-4	19	6.3 J	ND	ND	ND	ND	2.7 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018886-1,2	Soil	Field	1/9/95	DF3-5	9	ND	ND	ND	ND	ND	2.4 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018887-1,2	Soil	Field	1/9/95	DF3-5	19	8.8 J	ND	1.7 J	ND	2.1 J	2.5 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018888-1,2	Soil	Field	1/9/95	DF3-6	9	ND	ND	ND	ND	1.1 J	2.6 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018889-1,2	Soil	Dupl.	1/9/95	DFD3-6	9	3.4 J	ND	ND	ND	1.6 J	2.8 B,J	ND	ND	ND	ND	ND	ND	NS	ug/kg
018890-1,2	Soil	Field	1/9/95	DF3-6	19	ND	ND	ND	ND	ND	1.8 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018899-1,2	Water	EB	1/10/95	Site 147	NA	ND	ND	ND	ND	ND	3.3 B,J	ND	ND	ND	ND	ND	ND	NS	ug/l.
021452-1	Soil	TB	1/12/95	Site 147	NA	150	1.5 J	8.2 J	53	2.3 J	12 B	1.2 J	7.5	7	NS	NS	NS	NS	ug/kg

Section 6.4, continued:

ER Site 147
Summary of Organic Constituents in Confirmatory Soil Samples
Collected in the Three Drainfields and Around the Three Septic Tanks

Sample Number	Sample Matrix	Sample Type	Sample Date	Sample Location (Figures 1-2 or 1-3)	Top of Sample Interval (fbgs)	VOCs Method 8240									SVOCs Method 8270			TNT Screen Colorimetric Method Based on EPA 8515	Units
						Acetone	Ethyl-Benz.	2-Hexa-none	MEK	MIBK	Meth. Chloride	PCE	Toluene	Total Xylenes	BEHP	DNBP	Phenol		
West Septic Tank Soil Samples:																			
018874-1,2	Soil	Field	1/4/95	ST1-1	9	10	ND	ND	ND	ND	2.3 J	ND	1 J	ND	ND	ND	ND	ND	ug/kg
018875-1,2	Soil	Field	1/4/95	ST1-2	9	13	ND	ND	2.3 J	2.2 J	2.8 B,J	ND	2 J	ND	ND	ND	ND	ND	ug/kg
West Drainfield Soil Samples:																			
018861-1,2	Soil	Field	1/3/95	DF1-1	5	18	ND	ND	ND	2.4 J	2 J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018862-1,2	Soil	Field	1/3/95	DF1-1	15	29	ND	ND	ND	2.3 J	2 J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018872-1,2	Soil	Field	1/4/95	DF1-2	5	15	ND	ND	4.3 J	1.9 J	2.2 J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018873-1,2	Soil	Field	1/4/95	DF1-2	15	16	ND	ND	ND	ND	2.6 J	ND	1.6 J	ND	ND	ND	ND	ND	ug/kg
018863-1,2	Soil	Field	1/3/95	DF1-3	5	33	ND	ND	4.9 J	2 J	2.2 J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018864-1,2	Soil	Field	1/3/95	DF1-3	15	12	ND	ND	ND	ND	2 J	ND	ND	ND	58 J	ND	53 J	ND	ug/kg
018870-1,2	Soil	Field	1/4/95	DF1-4	5	27	ND	ND	ND	ND	2.7 J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018871-1,2	Soil	Field	1/4/95	DF1-4	15	17	ND	ND	ND	2 J	2.4 J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018865-1,2	Soil	Field	1/3/95	DF1-5	5	17	ND	ND	ND	ND	2 J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018867-1,2	Soil	Dupl.	1/3/95	DFD1-5	5	47	ND	ND	6.2 J	2.6 J	2 J	ND	ND	ND	ND	ND	ND	NS	ug/kg
018866-1,2	Soil	Field	1/3/95	DF1-5	15	10	ND	ND	ND	ND	1.8 J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018868-1,2	Soil	Field	1/3/95	DF1-6	5	22	ND	ND	ND	3.6 J	2.3 J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018869-1,2	Soil	Field	1/3/95	DF1-6	15	12	ND	11	ND	4.1 J	2.1 J	ND	ND	ND	ND	ND	ND	ND	ug/kg

Section 6.4, continued:

ER Site 147
Summary of Organic Constituents in Confirmatory Soil Samples
Collected in the Three Drainfields and Around the Three Septic Tanks

Sample Number	Sample Matrix	Sample Type	Sample Date	Sample Location (Figures 1-2 or 1-3)	Top of Sample Interval (fbgs)	VOCs Method 8240									SVOCs Method 8270			TNT Screen Colorimetric Method Based on EPA 8515	Units
						Acetone	Ethyl-Benz.	2-Hexa-none	MEK	MIBK	Meth. Chloride	PCE	Toluene	Total Xylenes	BEHP	DNBP	Phenol		
South Septic Tank Soil Samples:																			
018884-1,2	Soil	Field	1/9/95	ST3-1	10	5.5 J	ND	ND	ND	1.1 J	3.1 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018885-1,2	Soil	Field	1/9/95	ST3-2	10	ND	ND	ND	ND	1 J	3.3 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
South Drainfield Soil and QA Samples:																			
018878-1,2	Soil	Field	1/5/95	DF2-1	5	3.7 J	ND	ND	ND	ND	1.6 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018879-1,2	Soil	Field	1/5/95	DF2-1	15	7.4 J	ND	ND	ND	ND	2.6 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018880-1,2	Soil	Field	1/5/95	DF2-2	5	1.7 J	ND	ND	ND	ND	2 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018881-1,2	Soil	Field	1/5/95	DF2-2	15	ND	ND	ND	ND	ND	2.1 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018882-1,2	Soil	Field	1/5/95	DF2-3	5	ND	ND	ND	ND	ND	2 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
018883-1,2	Soil	Field	1/5/95	DF2-3	15	1.5 J	ND	ND	ND	ND	2 B,J	ND	ND	ND	ND	ND	ND	ND	ug/kg
021402-1	Soil	TB	1/5/95	Site 147	NA	22	ND	ND	14	ND	4.1 B,J	ND	1.5 J	1.2 B,J	NS	NS	NS	NS	ug/kg
Laboratory Reporting Limit for Soil						10	5	10	10	10	5	5	5	5	330	330	330	1,000	ug/kg
Laboratory Reporting Limit for Water						10	5	10	10	10	5	5	5	5	10	10	10	NA	ug/L
Proposed Subpart S Action Level For Soil						8E+06	8E+06	None	5E+07	4E+06	9E+04	1E+04	2E+07	2E+08	5E+04	8E+06	5E+07	4E+04	ug/kg

Notes:

B = Compound detected in associated blank sample
BEHP = Bis(2-Ethylhexyl)phthalate
DNBP = Di-n-butyl-phthalate
Dupl. = Duplicate soil sample
EB = Equipment blank
Ethyl-benz. = Ethylbenzene
fbgs = feet below ground surface
J = Result is below the reporting limit or is an estimated concentration.
MEK = Methyl ethyl ketone
Meth. chloride = Methylene chloride
MIBK = 4-Methyl-2-pentanone
NA = Not applicable
ND = Not detected
NS = No sample
PCE = Tetrachloroethene
QA = Quality assurance
SVOCs = Semivolatile organic compounds
TB = Trip blank
TNT = Trinitrotoluene
ug/kg = Micrograms per kilogram
ug/L = Micrograms per liter
VOCs = Volatile organic compounds

Setion 6.4, continued:

ER Site 147
Summary of RCRA Metals in Confirmatory Soil Samples
Collected in the Three Drainfields and Around the Three Septic Tanks

Sample Number	Sample Matrix	Sample Type	Sample Date	Sample Location (Figures 1-2 or 1-3)	Top of Sample Interval (fbgs)	RCRA Metals, Methods 6010 and 7471								Units
						As	Ba	Cd	Cr, total	Pb	Hg	Se	Ag	
North Septic Tank Soil Samples:														
018876-2	Soil	Field	1/4/95	ST2-1	9	2.3	50.2	ND	3.7	5.6	ND	ND	ND	mg/kg
018877-2	Soil	Field	1/4/95	ST2-2	9	2.3	66.5	ND	3.7	4.1 J	ND	ND	ND	mg/kg
North Drainfield Soil and QA Samples:														
018894-2	Soil	Field	1/10/95	DF3-1	9	3.8	68.8	ND	7.8	5.8	ND	ND	ND	mg/kg
018895-2	Soil	Field	1/10/95	DF3-1	19	3.1	62.7	ND	5.4	5.5	ND	ND	ND	mg/kg
018896-2	Soil	Field	1/10/95	DF3-2	9	6.9	34.0	ND	4.0	6.0	ND	ND	ND	mg/kg
018897-2	Soil	Field	1/10/95	DF3-2	19	4.1	100	ND	5.6	10.3	ND	ND	ND	mg/kg
018892-2	Soil	Field	1/9/95	DF3-3	9	3.7	107	ND	4.7	4.6 J	ND	ND	ND	mg/kg
018893-2	Soil	Field	1/9/95	DF3-3	19	3	64.1	ND	5.5	39.7	ND	ND	ND	mg/kg
018891-2	Soil	Field	1/9/95	DF3-4	9	4.3	69.9	ND	5.5	7.4	ND	ND	0.44 J	mg/kg
018898-2	Soil	Field	1/10/95	DF3-4	19	2.2	65.6	ND	5.0	5.3	ND	ND	ND	mg/kg
018886-2	Soil	Field	1/9/95	DF3-5	9	5	94.6	ND	5.2	5.5	ND	ND	ND	mg/kg
018887-2	Soil	Field	1/9/95	DF3-5	19	3.7	78.3	ND	6.2	6.5	ND	ND	ND	mg/kg
018888-2	Soil	Field	1/9/95	DF3-6	9	4.2	140	ND	6.2	12.3	ND	ND	ND	mg/kg
018889-2	Soil	Dupl	1/9/95	DFD3-6	9	3.5	110	ND	4.9	9.6	ND	ND	ND	mg/kg
018890-2	Soil	Field	1/9/95	DF3-6	19	3.3	66.4	ND	5.6	14.4	ND	ND	ND	mg/kg
018899-3.4	Water	EB	1/10/95	Site 147	NA	ND	ND	ND	ND	0.003	ND	ND	ND	mg/L
West Septic Tank Soil Samples:														
018874-2	Soil	Field	1/4/95	ST1-1	9	2.7	51.5	ND	4.1	5.5	ND	ND	ND	mg/kg
018875-2	Soil	Field	1/4/95	ST1-2	9	3.2	138	ND	4.7	5.1	ND	ND	ND	mg/kg
West Drainfield Soil Samples:														
018861-2	Soil	Field	1/3/95	DF1-1	5	4.3	176	ND	3.6	4.3 J	ND	ND	ND	mg/kg
018862-2	Soil	Field	1/3/95	DF1-1	15	3.9	49.9	ND	4.6	7.5	ND	ND	ND	mg/kg
018872-2	Soil	Field	1/4/95	DF1-2	5	5.8	355	ND	3.2	5.7	ND	ND	ND	mg/kg
018873-2	Soil	Field	1/4/95	DF1-2	15	3.1	74.5	ND	3.9	7.4	ND	ND	ND	mg/kg

Section 6.4, continued:

ER Site 147
Summary of RCRA Metals in Confirmatory Soil Samples
Collected in the Three Drainfields and Around the Three Septic Tanks

Sample Number	Sample Matrix	Sample Type	Sample Date	Sample Location (Figures 1-2 or 1-3)	Top of Sample Interval (fbgs)	RCRA Metals, Methods 6010 and 7471								Units
						As	Ba	Cd	Cr, total	Pb	Hg	Se	Ag	
West Drainfield Soil Samples, continued:														
018863-2	Soil	Field	1/3/95	DF1-3	5	3.6	212	ND	3.9	7.7	ND	ND	ND	mg/kg
018864-2	Soil	Field	1/3/95	DF1-3	15	2.9	52.8	ND	3.5	5.0	ND	ND	ND	mg/kg
018870-2	Soil	Field	1/4/95	DF1-4	5	5	173	ND	3.0	3.1 J	ND	ND	ND	mg/kg
018871-2	Soil	Field	1/4/95	DF1-4	15	3.6	69.7	ND	3.9	9.9	ND	ND	ND	mg/kg
018865-2	Soil	Field	1/3/95	DF1-5	5	3.2	151	ND	4.4	4.8 J	ND	ND	ND	mg/kg
018867-2	Soil	Dupl.	1/3/95	DFD1-5	5	5.1	181	ND	4.2	4.8 J	ND	ND	ND	mg/kg
018866-2	Soil	Field	1/3/95	DF1-5	15	2.7	40.8	ND	4.8	6.7	ND	ND	ND	mg/kg
018868-2	Soil	Field	1/3/95	DF1-6	5	4.8	117	ND	3.5	4.3 J	ND	ND	ND	mg/kg
018869-2	Soil	Field	1/3/95	DF1-6	15	2	34.2	ND	3.7	5.5	ND	ND	ND	mg/kg
South Septic Tank Soil Samples:														
018884-2	Soil	Field	1/9/95	ST3-1	10	5.1	245	ND	6.9	8.4	ND	ND	ND	mg/kg
018885-2	Soil	Field	1/9/95	ST3-2	10	5.4	241	ND	6.1	7.9	ND	ND	ND	mg/kg
South Drainfield Soil Samples:														
018878-2	Soil	Field	1/5/95	DF2-1	5	2.5	76.2	ND	2.7	7.3	ND	ND	ND	mg/kg
018879-2	Soil	Field	1/5/95	DF2-1	15	4.2	50.8	ND	6.3	4.3 J	ND	ND	ND	mg/kg
018880-2	Soil	Field	1/5/95	DF2-2	5	3.7	57.6	ND	5.1	6.0	ND	ND	ND	mg/kg
018881-2	Soil	Field	1/5/95	DF2-2	15	3.1	34.3	ND	6.4	23.3	ND	ND	ND	mg/kg
018882-2	Soil	Field	1/5/95	DF2-3	5	3.6	75.5	ND	4.6	8.1	ND	ND	ND	mg/kg
018883-2	Soil	Field	1/5/95	DF2-3	15	2.2	37.1	ND	5.4	4.0 J	ND	ND	ND	mg/kg
Laboratory Reporting Limit for Soil						1	1	0.5	1	5	0.1	0.5	1	mg/kg
Laboratory Reporting Limit for Water						0.01	0.01	0.005	0.01	0.003	0.0002	0.005	0.01	mg/L
Number of SNL/NM Background Soil Sample Analyses *						15	727	1,740	647	536	1,724	2,134	2,302	NA
SNL/NM Soil Background Range *						2.1-7.9	0.5-495	0.0027-6.2	0.5-31.4	0.75-103	0.0001-0.68	0.037-17.2	0.0016-8.7	mg/kg
SNL/NM Soil Background UTL or 95th Percentile *						7	214	0.9	15.9	11.8	<0.1	<1.0	<1.0	mg/kg
Proposed Subpart S Action Level For Soil						0.50	6,000	80	80,000 **	400 ***	20	400	400	mg/kg

Section A-4, continued:

ER Site 147
Summary of RCRA Metals in Confirmatory Soil Samples
Collected in the Three Drainfields and Around the Three Septic Tanks

Notes:

As = Arsenic. Arsenic background concentrations presented above are based on analyses of subsurface soil samples collected in the Coyote Test Field (CTF) area.

Ba = Barium. Barium background concentrations presented above are based on analyses of subsurface soil samples collected in the Southwest and CTF areas.

Cd = Cadmium. Cadmium background concentrations presented above are based on analyses of subsurface soil samples collected in the North, Tijeras, Southwest, CTF, and Offsite areas.

Cr = Chromium. Chromium background concentrations presented above are based on analyses of subsurface soil samples collected in the Southwest area.

Pb = Lead. Lead background concentrations presented above are based on analyses of subsurface samples collected in the Southwest and Offsite areas.

Hg = Mercury. Mercury background concentrations presented above are based on analyses of subsurface soil samples collected in the North, Tijeras, Southwest, CTF and Offsite areas.

Se = Selenium. Selenium background concentrations presented above are based on analyses of surface and subsurface soil samples collected in the North, Tijeras, Southwest, CTF and Offsite areas.

Ag = Silver. Silver background concentrations presented above are based on analyses of subsurface soil samples collected in the North, Tijeras, Southwest, CTF, and Offsite areas.

Dupl. = Duplicate soil sample

EB = Equipment blank

fbgs = Feet below ground surface

J = Result is below the reporting limit or is an estimated concentration.

mg/kg = Milligrams per kilogram

mg/L = Milligrams per liter

NA = Not applicable

ND = Not detected

QA = Quality assurance

UTL = Upper Tolerance Limit

* IT March 1996

** 80,000 mg kg is for Cr^{3+} only. For Cr^{6+}, proposed Subpart S action level is 400 mg/kg.

*** No proposed Subpart S action level for lead in soil, 400 ppm is EPA proposed action level (EPA July 1994)

Section 6.4, continued:

ER Site 147
Summary of Isotopic Uranium and Tritium in Confirmatory Soil Samples
Collected in the Three Drainfields and Around the Three Septic Tanks

Sample Number	Sample Matrix	Sample Type	Sample Date	Sample Location (Figures 1-2 or 1-3)	Top of Sample Interval (fbgs)	Isotopic Uranium Method HASL-300									Tritium Method EPA-600 906.0			Units
						U-233/ U-234 Result	U-233/ U-234 Error *	U-233/ U-234 M.D.A.	U-235 Result	U-235 Error *	U-235 M.D.A.	U-238 Result	U-238 Error *	U-238 M.D.A.	Result	Error*	M.D.A.	
North Drainfield Soil and QA Samples:																		
018894-5	Soil	Field	1/10/95	DF3-1	9	0.74	0.14	0.027	0.027	0.022	0.012	0.67	0.13	0.027				pCi/g
018895-5	Soil	Field	1/10/95	DF3-1	19	1.3	0.21	0.049	0.054	0.036	0.039	1.1	0.19	0.065				pCi/g
018896-5	Soil	Field	1/10/95	DF3-2	9	0.89	0.16	0.032	0.029	0.025	0.027	0.91	0.16	0.027				pCi/g
018897-5	Soil	Field	1/10/95	DF3-2	19	0.79	0.15	0.043	0.022 J	0.023	0.032	0.81	0.15	0.046				pCi/g
018892-5	Soil	Field	1/9/95	DF3-3	9	1.2	0.41	0.28	ND	0.089	0.22	0.67	0.29	0.27				pCi/g
018893-5	Soil	Field	1/9/95	DF3-3	19	0.96	0.16	0.028	0.041	0.029	0.032	1.0	0.17	0.032				pCi/g
018891-5	Soil	Field	1/9/95	DF3-4	9	0.77	0.15	0.045	0.035	0.03	0.035	0.83	0.16	0.041				pCi/g
018898-5	Soil	Field	1/10/95	DF3-4	19	0.98	0.17	0.012	0.039	0.026	0.012	0.80	0.14	0.026				pCi/g
018886-5	Soil	Field	1/9/95	DF3-5	9	0.77	0.14	0.043	0.027	0.022	0.012	0.73	0.14	0.04				pCi/g
018887-5	Soil	Field	1/9/95	DF3-5	19	0.91	0.18	0.074	0.011 J	0.024	0.045	0.90	0.18	0.061				pCi/g
018888-5	Soil	Field	1/9/95	DF3-6	9	0.80	0.16	0.06	0.011 J	0.024	0.045	0.84	0.20	0.092				pCi/g
018889-5	Soil	Dupl.	1/9/95	DFD3-6	9	0.86	0.19	0.056	0.072	0.053	0.056	0.84	0.20	0.092				pCi/g
018890-5	Soil	Field	1/9/95	DF3-6	19	0.99	0.18	0.041	0.023 J	0.027	0.041	0.91	0.17	0.041				pCi/g
018899-5	Water	EB	1/10/95	Site 147	NA	0.085	0.056	0.06	ND	0.014	0.052	0.036 J	0.057	0.096				pCi/L
018886-4	Soil Moist.	Compos.	1/9/95	DF3-1/6	9										ND	140	230	pCi/L
018887-4	Soil Moist.	Compos.	1/9/95	DF3-1/6	19										ND	140	230	pCi/L
North Septic Tank Soil Samples:																		
018876-5	Soil	Field	1/4/95	ST2-1	9	1.00	0.16	0.056	0.066	0.035	0.038	0.85	0.14	0.048				pCi/g
018877-5	Soil	Field	1/4/95	ST2-2	9	0.96	0.15	0.03	0.032	0.022	0.01	0.99	0.16	0.04				pCi/g

Section 6.4, continued:

ER Site 147
Summary of Isotopic Uranium and Tritium in Confirmatory Soil Samples
Collected in the Three Drainfields and Around the Three Septic Tanks

Sample Number	Sample Matrix	Sample Type	Sample Date	Sample Location (Figures 1-2 or 1-3)	Top of Sample Interval (fbgs)	Isotopic Uranium Method HASL-300									Tritium Method EPA-600 906.0			Units
						U-233/ U-234 Result	U-233/ U-234 Error *	U-233/ U-234 M.D.A.	U-235 Result	U-235 Error *	U-235 M.D.A.	U-238 Result	U-238 Error *	U-238 M.D.A.	Result	Error*	M.D.A.	
West Drainfield Soil Samples:																		
018861-5	Soil	Field	1/3/95	DF1-1	5	1.00	0.160	0.028	0.037	0.03	0.023	0.81	0.140	0.050				pCi/g
018862-5	Soil	Field	1/3/95	DF1-1	15	0.81	0.14	0.037	0.041	0.03	0.021	0.80	0.14	0.046				pCi/g
018872-5	Soil	Field	1/4/95	DF1-2	5	0.97	0.17	0.033	0.019	0.02	0.013	0.86	0.16	0.028				pCi/g
018873-5	Soil	Field	1/4/95	DF1-2	15	0.96	0.17	0.036	0.035	0.03	0.012	1.10	0.18	0.026				pCi/g
018863-5	Soil	Field	1/3/95	DF1-3	5	0.75	0.15	0.047	0.016 J	0.026	0.047	0.72	0.15	0.064				pCi/g
018864-5	Soil	Field	1/3/95	DF1-3	15	0.99	0.19	0.091	ND	0.028	0.056	0.84	0.17	0.074				pCi/g
018870-5	Soil	Field	1/4/95	DF1-4	5	0.88	0.20	0.071	0.055	0.042	0.021	0.86	0.19	0.021				pCi/g
018871-5	Soil	Field	1/4/95	DF1-4	15	0.89	0.17	0.081	0.021 J	0.04	0.066	0.91	0.17	0.044				pCi/g
018865-5	Soil	Field	1/3/95	DF1-5	5	0.89	0.15	0.044	0.055	0.03	0.011	0.77	0.14	0.044				pCi/g
018867-5	Soil	Dupl.	1/3/95	DFD1-5	5	0.80	0.15	0.051	0.041	0.03	0.029	0.87	0.16	0.047				pCi/g
018866-5	Soil	Field	1/3/95	DF1-5	15	0.80	0.15	0.048	0.044	0.04	0.044	0.74	0.15	0.044				pCi/g
018868-5	Soil	Field	1/3/95	DF1-6	5	1.10	0.20	0.086	0.053 J	0.044	0.061	0.90	0.17	0.072				pCi/g
018869-5	Soil	Field	1/3/95	DF1-6	15	0.74	0.14	0.05	0.053	0.036	0.034	0.75	0.14	0.034				pCi/g
018861-4	Soil Moist.	Compos.	1/3/95	DF1-1/6	5										450 B	150	230	pCi/L
018862-4	Soil Moist.	Compos.	1/3/95	DF1-1/6	15										350 B	140	210	pCi/L
West Septic Tank Soil Samples:																		
018874-5	Soil	Field	1/4/95	ST1-1	9	0.83	0.14	0.037	0.019 J	0.018	0.021	0.81	0.14	0.046				pCi/g
018875-5	Soil	Field	1/4/95	ST1-2	9	0.86	0.14	0.033	0.026 J	0.024	0.033	0.83	0.14	0.039				pCi/g

Section 6.4, continued:

ER Site 147
Summary of Isotopic Uranium and Tritium in Confirmatory Soil Samples
Collected in the Three Drainfields and Around the Three Septic Tanks

Sample Number	Sample Matrix	Sample Type	Sample Date	Sample Location (Figures 1-2 or 1-3)	Top of Sample Interval (fbgs)	Isotopic Uranium Method HASL-300									Tritium Method EPA-600 906.0			Units
						U-233/ U-234 Result	U-233/ U-234 Error *	U-233/ U-234 M.D.A.	U-235 Result	U-235 Error *	U-235 M.D.A.	U-238 Result	U-238 Error *	U-238 M.D.A.	Result	Error*	M.D.A.	
South Drainfield Soil Samples:																		
018878-5	Soil	Field	1/5/95	DF2-1	5	1.10	0.17	0.04	0.03	0.03	0.03	1.00	0.16	0.037				pCi/g
018879-5	Soil	Field	1/5/95	DF2-1	15	0.95	0.15	0.03	0.04	0.02	0.02	0.81	0.14	0.036				pCi/g
018880-5	Soil	Field	1/5/95	DF2-2	5	1.30	0.19	0.03	0.05	0.03	0.01	1.30	0.19	0.025				pCi/g
018881-5	Soil	Field	1/5/95	DF2-2	15	0.94	0.13	0.02	0.05	0.02	0.01	1.00	0.13	0.016				pCi/g
018882-5	Soil	Field	1/5/95	DF2-3	5	1.10	0.16	0.05	0.07	0.03	0.02	1.20	0.16	0.028				pCi/g
018883-5	Soil	Field	1/5/95	DF2-3	15	0.89	0.12	0.02	0.03	0.02	0.01	0.92	0.13	0.006				pCi/g
018878-4	oil Moist.	Compos.	1/5/95	DF2-1/3	5										ND	140	230	pCi/L
018879-4	oil Moist.	Compos.	1/5/95	DF2-1/3	15										ND	140	230	pCi/L
South Septic Tank Soil Samples:																		
018884-5	Soil	Field	1/9/95	ST3-1	10	1.30	0.26	0.10	0.077 J	0.061	0.080	1.10	0.23	0.11				pCi/g
018885-5	Soil	Field	1/9/95	ST3-2	10	1.20	0.20	0.05	0.041	0.033	0.041	1.20	0.19	0.053				pCi/g
Number of SNL/NM Background Soil Sample Analyses **						14			283			90			U			
SNL/NM Soil Background Range **						0.44-<5.02			0.004-3			0.153-2.3			U			pCi/g
SNL/NM Soil Background 95th Percentile **						<5.02			0.16			1.4			U			pCi/g
Nationwide Tritium Range in Precipation and Drinking Water ***						NA			NA			NA			100-400			pCi/L

Section 6.4, concluded:

ER Site 147
Summary of Isotopic Uranium and Tritium in Confirmatory Soil Samples
Collected in the Three Drainfields and Around the Three Septic Tanks

Notes:

U-233 = Uranium 233

U-234 = Uranium 234. Uranium 233/234 background concentrations presented above are based on analyses of surface and subsurface soil samples collected in the Southwest area.

U-235 = Uranium 235. Uranium 235 background concentrations presented above are based on analyses of surface and subsurface soil samples collected in the Southwest area.

U-238 = Uranium 238. Uranium 238 background concentrations presented above are based on analyses of surface and subsurface soil samples collected in the Southwest area.

B = Compound detected in associated blank sample
Compos. = Composite sample
fbgs = Feet below ground surface
J = Result is below the reporting limit or is an estimated concentration.
M.D.A. = Minimum detectable activity
ND = Not detected
pCi/g = Picocuries per gram
pCi/L = Picocuries per liter
QA = Quality assurance
U = Undefined for SNL/NM soils
UTL = Upper Tolerance Limit
* Error = +- 2 sigma uncertainty
** IT March 1996
*** EPA October 1993

ER Site 147
Gamma Spectroscopy Screening Results for the Shallow Interval
Composite Soil Sample From the North Drainfield

```
**************************************************************************
*                    Sandia National Laboratories                        *
*    Radiation Protection Sample Diagnostics Program [881 Laboratory]    *
*                        1-12-95  1:00:16 PM                             *
**************************************************************************
*                                                                        *
* Analyzed by: James Cole 1/10/95  Reviewed by:  1/13/95                 *
**************************************************************************

Customer            : B.GALLOWAY/E.RANKIN (7582/SMO)
Customer Sample ID  : 018886-03
Lab Sample ID       : 50003301

Sample Description  : MARINELLI SOLID SAMPLE
Sample Type         : Solid
Sample Geometry     : 1SMAR
Sample Quantity     :   810.000  Gram
Sample Date/Time    :  1-09-95   1:00:00 PM
Acquire Start Date  :  1-12-95  12:27:12 PM
Detector Name       : LAB01
Elapsed Live Time   :   1800 seconds
Elapsed Real Time   :   1801 seconds

Comments:

**************************************************************************
```

Nuclide	Activity (pCi/Gram)	2S Error	MDA
U-238	Not Detected	--------	2.03
TH-234	8.21E-01	3.33E-01	4.92E-01
U-234	Not Detected	--------	5.37E+01
RA-226	7.71E-01	3.20E-01	4.71E-01
PB-214	4.74E-01	1.34E-01	4.67E-02
BI-214	4.12E-01	8.56E-02	5.72E-02
PB-210	Not Detected	--------	5.16E+02
TH-232	4.26E-01	1.55E-01	1.43E-01
RA-228	6.29E-01	1.87E-01	2.06E-01
AC-228	5.66E-01	1.40E-01	1.19E-01
TH-228	Not Detected	--------	8.61E-01
RA-224	3.92E-01	2.54E-01	3.84E-01
PB-212	4.92E-01	1.55E-01	3.57E-02
BI-212	5.74E-01	2.51E-01	3.99E-01
TL-208	4.79E-01	1.08E-01	7.82E-02
U-235	Not Detected	--------	2.84E-01
TH-231	Not Detected	--------	6.82E-01
PA-231	Not Detected	--------	1.19
AC-227	Not Detected	--------	2.01
TH-227	Not Detected	--------	3.86E-01
RA-223	Not Detected	--------	2.49E-01
RN-219	Not Detected	--------	3.02E-01
PB-211	Not Detected	--------	6.99E-01
TL-207	Not Detected	--------	2.16E+01
AM-241	Not Detected	--------	2.96E-01
PU-239	Not Detected	--------	3.40E+02
NP-237	Not Detected	--------	4.72E-01
PA-233	Not Detected	--------	6.52E-02
TH-229	Not Detected	--------	3.62E-01

Section 6.5, concluded:

ER Site 147
Gamma Spectroscopy Screening Results for the Shallow Interval
Composite Soil Sample From the North Drainfield

[Summary Report] - Sample ID: 50003301

Nuclide	Activity (pCi/Gram)	2S Error	MDA
AG-110m	Not Detected	--------	4.68E-02
AR-41	Not Detected	--------	4.53E+10
BA-133	Not Detected	--------	6.75E-02
BA-140	Not Detected	--------	1.82E-01
CD-109	Not Detected	--------	8.06E-01
CD-115	Not Detected	--------	1.89E-01
CE-139	Not Detected	--------	3.34E-02
CE-141	Not Detected	--------	6.66E-02
CE-144	Not Detected	--------	2.91E-01
CO-56	Not Detected	--------	5.89E-02
CO-57	Not Detected	--------	3.95E-02
CO-58	Not Detected	--------	5.12E-02
CO-60	Not Detected	--------	6.65E-02
CR-51	Not Detected	--------	2.90E-01
CS-134	Not Detected	--------	5.22E-02
CS-137	Not Detected	--------	5.49E-02
CU-64	Not Detected	--------	6.85E+02
EU-152	Not Detected	--------	4.00E-01
EU-154	Not Detected	--------	2.48E-01
EU-155	Not Detected	--------	1.82E-01
FE-59	Not Detected	--------	1.23E-01
GD-153	Not Detected	--------	1.31E-01
HG-203	Not Detected	--------	3.26E-02
I-131	Not Detected	--------	4.52E-02
IN-115m	Not Detected	--------	4.83E+03
IR-192	Not Detected	--------	3.21E-02
K-40	1.92E+01	2.83	3.48E-01
LA-140	Not Detected	--------	2.20E-01
MN-54	Not Detected	--------	5.54E-02
MN-56	Not Detected	--------	1.36E+07
MO-99	Not Detected	--------	8.48E-01
NA-22	Not Detected	--------	7.10E-02
NA-24	Not Detected	--------	1.68
NB-95	Not Detected	--------	3.10E-01
ND-147	Not Detected	--------	3.50E-01
NI-57	Not Detected	--------	3.26E-01
BE-7	Not Detected	--------	3.26E-01
RU-103	Not Detected	--------	3.70E-02
RU-106	Not Detected	--------	3.93E-01
SB-122	Not Detected	--------	1.16E-01
SB-124	Not Detected	--------	4.31E-02
SB-125	Not Detected	--------	1.01E-01
SC-46	Not Detected	--------	8.08E-02
SR-85	Not Detected	--------	4.80E-02
TA-182	Not Detected	--------	2.39E-01
TA-183	Not Detected	--------	3.82E-01
TE-132	Not Detected	--------	5.52E-02
TL-201	Not Detected	--------	2.58E-01
XE-133	Not Detected	--------	3.57E-01
Y-88	Not Detected	--------	6.21E-02
ZN-65	Not Detected	--------	1.52E-01
ZR-95	Not Detected	--------	9.08E-02

ER Site 147
Gamma Spectroscopy Screening Results for the Deep Interval
Composite Soil Sample From the North Drainfield

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**********************************************************************
*                    Sandia National Laboratories                    *
*    Radiation Protection Sample Diagnostics Program [881 Laboratory]*
*                        1-12-95  1:39:35 PM                         *
**********************************************************************
*                                                                    *
* Analyzed by: George Cole 1/12/95 Reviewed by:  1/13/95             *
**********************************************************************

Customer            : B.GALLOWAY/E.RANKIN (7582/SMO)
Customer Sample ID  : 018887-03
Lab Sample ID       : 50003302

Sample Description  : MARINELLI SOLID SAMPLE
Sample Type         : Solid
Sample Geometry     : 1SMAR
Sample Quantity     :   733.000  Gram
Sample Date/Time    :  1-09-95   1:15:00 PM
Acquire Start Date  :  1-12-95   1:06:31 PM
Detector Name       : LAB01
Elapsed Live Time   :   1800 seconds
Elapsed Real Time   :   1801 seconds

Comments:

**********************************************************************
```

Nuclide	Activity (pCi/Gram)	2S Error	MDA
U-238	Not Detected	--------	2.27
TH-234	7.57E-01	3.46E-01	5.44E-01
U-234	Not Detected	--------	6.00E+01
RA-226	1.05	3.99E-01	5.18E-01
PB-214	4.93E-01	1.40E-01	5.03E-02
BI-214	5.32E-01	1.06E-01	6.20E-02
PB-210	Not Detected	--------	5.51E+02
TH-232	5.11E-01	1.93E-01	1.54E-01
RA-228	6.18E-01	1.96E-01	1.92E-01
AC-228	Not Detected	--------	3.25E-01
TH-228	5.99E-01	3.10E-01	4.89E-01
RA-224	5.68E-01	3.07E-01	4.16E-01
PB-212	4.96E-01	1.56E-01	3.86E-02
BI-212	6.77E-01	3.07E-01	4.44E-01
TL-208	4.63E-01	1.08E-01	8.41E-02
U-235	Not Detected	--------	3.01E-01
TH-231	Not Detected	--------	7.68E-01
PA-231	Not Detected	--------	1.30
AC-227	Not Detected	--------	2.11
TH-227	Not Detected	--------	4.24E-01
RA-223	Not Detected	--------	2.79E-01
RN-219	Not Detected	--------	3.26E-01
PB-211	Not Detected	--------	8.41E-01
TL-207	Not Detected	--------	2.24E+01
AM-241	Not Detected	--------	3.26E-01
PU-239	Not Detected	--------	3.63E+02
NP-237	Not Detected	--------	2.60E-01
PA-233	Not Detected	--------	7.12E-02
TH-229	Not Detected	--------	3.99E-01

Section 6.6, concluded:

ER Site 147
Gamma Spectroscopy Screening Results for the Deep Interval
Composite Soil Sample From the North Drainfield

[Summary Report] - Sample ID: 50003302

Nuclide	Activity (pCi/Gram)	2S Error	MDA
AG-110m	Not Detected	--------	5.04E-02
AR-41	Not Detected	--------	6.28E+10
BA-133	Not Detected	--------	7.20E-02
BA-140	Not Detected	--------	1.76E-01
CD-109	Not Detected	--------	8.98E-01
CD-115	Not Detected	--------	2.03E-01
CE-139	Not Detected	--------	3.77E-02
CE-141	Not Detected	--------	7.39E-02
CE-144	Not Detected	--------	3.25E-01
CO-56	Not Detected	--------	6.34E-02
CO-57	Not Detected	--------	4.37E-02
CO-58	Not Detected	--------	5.74E-02
CO-60	Not Detected	--------	7.46E-02
CR-51	Not Detected	--------	3.28E-01
CS-134	Not Detected	--------	5.86E-02
CS-137	Not Detected	--------	5.69E-02
CU-64	Not Detected	--------	7.74E+02
EU-152	Not Detected	--------	4.29E-01
EU-154	Not Detected	--------	2.94E-01
EU-155	Not Detected	--------	1.97E-01
FE-59	Not Detected	--------	1.35E-01
GD-153	Not Detected	--------	1.45E-01
HG-203	Not Detected	--------	3.66E-02
I-131	Not Detected	--------	4.89E-02
IN-115m	Not Detected	--------	5.51E+03
IR-192	Not Detected	--------	3.62E-02
K-40	2.16E+01	3.28	3.67E-01
LA-140	Not Detected	--------	2.45E-01
MN-54	Not Detected	--------	6.37E-02
MN-56	Not Detected	--------	1.63E+07
MO-99	Not Detected	--------	9.29E-01
NA-22	Not Detected	--------	8.12E-02
NA-24	Not Detected	--------	1.88
NB-95	Not Detected	--------	3.38E-01
ND-147	Not Detected	--------	3.42E-01
NI-57	Not Detected	--------	3.80E-01
BE-7	Not Detected	--------	3.52E-01
RU-103	Not Detected	--------	4.28E-02
RU-106	Not Detected	--------	4.53E-01
SB-122	Not Detected	--------	1.36E-01
SB-124	Not Detected	--------	4.72E-02
SB-125	Not Detected	--------	1.09E-01
SC-46	Not Detected	--------	9.33E-02
SR-85	Not Detected	--------	5.48E-02
TA-182	Not Detected	--------	2.74E-01
TA-183	Not Detected	--------	4.22E-01
TE-132	Not Detected	--------	6.20E-02
TL-201	Not Detected	--------	2.93E-01
XE-133	Not Detected	--------	3.90E-01
Y-88	Not Detected	--------	7.06E-02
ZN-65	Not Detected	--------	1.75E-01
ZR-95	Not Detected	--------	1.05E-01

ER Site 147
Gamma Spectroscopy Screening Results for the Shallow Interval
Composite Soil Sample From the West Drainfield

```
**********************************************************************
*                    Sandia National Laboratories                    *
*    Radiation Protection Sample Diagnostics Program [881 Laboratory]*
*                       1-09-95 10:11:15 AM                          *
**********************************************************************
*                                                                    *
* Analyzed by: J.W. Cole 1/9/95  Reviewed by: 1/9/95                 *
**********************************************************************

Customer            : B.GALLOWAY/E.RANKIN (7582/SMO)
Customer Sample ID  : 018861-03
Lab Sample ID       : 50001901

Sample Description  : MARINELLI SOLID SAMPLE
Sample Type         : Solid
Sample Geometry     : 1SMAR
Sample Quantity     :   789.000  Gram
Sample Date/Time    :  1-03-95  12:00:00 PM
Acquire Start Date  :  1-06-95  10:24:02 PM
Detector Name       : LAB01
Elapsed Live Time   :   3600 seconds
Elapsed Real Time   :   3602 seconds
```

RECEIVED
JAN 17 1995
SNL/SMO

Comments:

>>>>> NON-STANDARD SAMPLE GEOMETRY --- ALL VALUES ARE ESTIMATED.

Nuclide	Activity (pCi/Gram)	2S Error	MDA
U-238	Not Detected	--------	1.41
TH-234	4.96E-01	2.84E-01	3.57E-01
U-234	Not Detected	--------	3.76E+01
RA-226	8.40E-01	2.84E-01	3.41E-01
PB-214	4.43E-01	1.21E-01	3.43E-02
BI-214	5.03E-01	9.07E-02	3.76E-02
PB-210	Not Detected	--------	3.61E+02
TH-232	4.50E-01	1.45E-01	1.00E-01
RA-228	5.69E-01	1.39E-01	1.28E-01
AC-228	6.56E-01	1.27E-01	7.71E-02
TH-228	4.89E-01	2.21E-01	3.31E-01
RA-224	5.13E-01	2.51E-01	2.83E-01
PB-212	4.87E-01	1.50E-01	2.61E-02
BI-212	7.62E-01	2.15E-01	2.64E-01
TL-208	4.69E-01	9.53E-02	4.84E-02
U-235	Not Detected	--------	1.93E-01
TH-231	Not Detected	--------	4.88E-01
PA-231	Not Detected	--------	8.87E-01
AC-227	Not Detected	--------	1.37
TH-227	Not Detected	--------	2.72E-01
RA-223	Not Detected	--------	1.84E-01
RN-219	Not Detected	--------	2.06E-01
PB-211	Not Detected	--------	5.25E-01
TL-207	Not Detected	--------	1.46E+01
AM-241	Not Detected	--------	1.97E-01
PU-239	Not Detected	--------	1.46E+02
NP-237	Not Detected	--------	1.73E-01
PA-233	Not Detected	--------	4.63E-02
TH-229	Not Detected	--------	2.43E-01

ER Site 147
Gamma Spectroscopy Screening Results for the Shallow Interval
Composite Soil Sample From the West Drainfield

[Summary Report] - Sample ID: 50001901

Nuclide	Activity (pCi/Gram)	2S Error	MDA
AG-110m	Not Detected	--------	3.00E-02
AR-41	Not Detected	--------	1.99E+12
BA-133	Not Detected	--------	4.74E-02
BA-140	Not Detected	--------	1.17E-01
CD-109	Not Detected	--------	5.98E-01
CD-115	Not Detected	--------	1.46E-01
CE-139	Not Detected	--------	2.43E-02
CE-141	Not Detected	--------	4.71E-02
CE-144	Not Detected	--------	2.01E-01
CO-56	Not Detected	--------	3.57E-02
CO-57	Not Detected	--------	2.76E-02
CO-58	Not Detected	--------	3.27E-02
CO-60	Not Detected	--------	4.00E-02
CR-51	Not Detected	--------	1.95E-01
CS-134	Not Detected	--------	3.46E-02
CS-137	Not Detected	--------	3.36E-02
CU-64	Not Detected	--------	7.58E+02
EU-152	Not Detected	--------	2.36E-01
EU-154	Not Detected	--------	1.70E-01
EU-155	Not Detected	--------	1.22E-01
FE-59	Not Detected	--------	7.92E-02
GD-153	Not Detected	--------	9.17E-02
HG-203	Not Detected	--------	2.26E-02
I-131	Not Detected	--------	2.96E-02
IN-115m	Not Detected	--------	1.83E+04
IR-192	Not Detected	--------	2.20E-02
K-40	1.48E+01	2.14	2.17E-01
LA-140	Not Detected	--------	1.58E-01
MN-54	Not Detected	--------	3.28E-02
MN-56	Not Detected	--------	1.66E+08
MO-99	Not Detected	--------	5.82E-01
NA-22	Not Detected	--------	4.26E-02
NA-24	Not Detected	--------	1.66
NB-95	Not Detected	--------	2.37E-01
ND-147	Not Detected	--------	2.16E-01
NI-57	Not Detected	--------	2.65E-01
BE-7	Not Detected	--------	2.16E-01
RU-103	Not Detected	--------	2.45E-02
RU-106	Not Detected	--------	2.57E-01
SB-122	Not Detected	--------	8.61E-02
SB-124	Not Detected	--------	2.80E-02
SB-125	Not Detected	--------	6.72E-02
SC-46	Not Detected	--------	5.59E-02
SR-85	Not Detected	--------	3.45E-02
TA-182	Not Detected	--------	1.63E-01
TA-183	Not Detected	--------	2.71E-01
TE-132	Not Detected	--------	4.18E-02
TL-201	Not Detected	--------	1.97E-01
XE-133	Not Detected	--------	2.87E-01
Y-88	Not Detected	--------	3.64E-02
ZN-65	Not Detected	--------	9.86E-02
ZR-95	Not Detected	--------	6.41E-02

ER Site 147
Gamma Spectroscopy Screening Results for the Deep Interval
Composite Soil Sample From the West Drainfield

```
**********************************************************************
*                    Sandia National Laboratories                    *
*     Radiation Protection Sample Diagnostics Program [881 Laboratory]*
*                        1-09-95 10:24:28 AM                         *
**********************************************************************
*                                                                    *
* Analyzed by: Joann Cole 1/9/95    Reviewed by:  1/9/95             *
**********************************************************************

Customer            : B.GALLOWAY/E.RANKIN (7582/SMO)
Customer Sample ID  : 018862-03
Lab Sample ID       : 50001902

Sample Description  : MARINELLI SOLID SAMPLE
Sample Type         : Solid
Sample Geometry     : 1SMAR
Sample Quantity     :   849.000  Gram
Sample Date/Time    :  1-03-95  12:30:00 PM
Acquire Start Date  :  1-06-95  11:45:17 PM
Detector Name       : LAB01
Elapsed Live Time   :   3600 seconds
Elapsed Real Time   :   3602 seconds
```

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JAN 11 1995
SNL/SMO

Comments:

```
>>>>> NON-STANDARD SAMPLE GEOMETRY --- ALL VALUES ARE ESTIMATED.
**********************************************************************
```

Nuclide	Activity (pCi/Gram)	2S Error	MDA
U-238	8.78E-01	4.34E-01	6.93E-01
TH-234	6.08E-01	2.43E-01	3.53E-01
U-234	Not Detected	--------	3.68E+01
RA-226	7.24E-01	2.56E-01	3.25E-01
PB-214	4.54E-01	1.24E-01	3.29E-02
BI-214	4.40E-01	7.76E-02	3.61E-02
PB-210	Not Detected	--------	3.42E+02
TH-232	3.90E-01	1.28E-01	9.51E-02
RA-228	5.82E-01	1.39E-01	1.24E-01
AC-228	5.94E-01	1.16E-01	7.64E-02
TH-228	4.00E-01	1.91E-01	3.18E-01
RA-224	5.34E-01	2.49E-01	2.79E-01
PB-212	4.43E-01	1.37E-01	2.58E-02
BI-212	7.55E-01	2.09E-01	2.26E-01
TL-208	4.83E-01	9.32E-02	4.90E-02
U-235	Not Detected	--------	1.87E-01
TH-231	Not Detected	--------	4.64E-01
PA-231	Not Detected	--------	8.22E-01
AC-227	Not Detected	--------	1.31
TH-227	Not Detected	--------	2.55E-01
RA-223	Not Detected	--------	1.74E-01
RN-219	Not Detected	--------	2.02E-01
PB-211	Not Detected	--------	4.95E-01
TL-207	Not Detected	--------	1.35E+01
AM-241	Not Detected	--------	1.90E-01
PU-239	Not Detected	--------	2.27E+02
NP-237	Not Detected	--------	1.71E-01
PA-233	Not Detected	--------	4.55E-02
TH-229	Not Detected	--------	2.46E-01

ER Site 147
Gamma Spectroscopy Screening Results for the Deep Interval
Composite Soil Sample From the West Drainfield

[Summary Report] - Sample ID: 50001902

Nuclide	Activity (pCi/Gram)	2S Error	MDA
AG-110m	Not Detected	--------	2.95E-02
AR-41	Not Detected	--------	2.80E+12
BA-133	Not Detected	--------	4.60E-02
BA-140	Not Detected	--------	1.15E-01
CD-109	Not Detected	--------	6.10E-01
CD-115	Not Detected	--------	1.42E-01
CE-139	Not Detected	--------	2.36E-02
CE-141	Not Detected	--------	4.53E-02
CE-144	Not Detected	--------	1.97E-01
CO-56	Not Detected	--------	2.36E-02
CO-57	Not Detected	--------	2.68E-02
CO-58	Not Detected	--------	3.31E-02
CO-60	Not Detected	--------	3.99E-02
CR-51	Not Detected	--------	1.92E-01
CS-134	Not Detected	--------	3.19E-02
CS-137	Not Detected	--------	3.37E-02
CU-64	Not Detected	--------	8.15E+02
EU-152	Not Detected	--------	2.45E-01
EU-154	Not Detected	--------	1.60E-01
EU-155	Not Detected	--------	1.21E-01
FE-59	Not Detected	--------	8.10E-02
GD-153	Not Detected	--------	9.12E-02
HG-203	Not Detected	--------	2.23E-02
I-131	Not Detected	--------	2.98E-02
IN-115m	Not Detected	--------	2.00E+04
IR-192	Not Detected	--------	2.14E-02
K-40	1.92E+01	2.71	2.00E-01
LA-140	Not Detected	--------	1.57E-01
MN-54	Not Detected	--------	3.39E-02
MN-56	Not Detected	--------	2.20E+08
MO-99	Not Detected	--------	5.91E-01
NA-22	Not Detected	--------	4.38E-02
NA-24	Not Detected	--------	1.68
NB-95	Not Detected	--------	2.25E-01
ND-147	Not Detected	--------	2.12E-01
NI-57	Not Detected	--------	2.51E-01
BE-7	Not Detected	--------	2.13E-01
RU-103	Not Detected	--------	2.37E-02
RU-106	Not Detected	--------	2.52E-01
SB-122	Not Detected	--------	8.34E-02
SB-124	Not Detected	--------	2.73E-02
SB-125	Not Detected	--------	7.13E-02
SC-46	Not Detected	--------	5.45E-02
SR-85	Not Detected	--------	3.23E-02
TA-182	Not Detected	--------	1.59E-01
TA-183	Not Detected	--------	2.63E-01
TE-132	Not Detected	--------	4.26E-02
TL-201	Not Detected	--------	1.91E-01
XE-133	Not Detected	--------	2.83E-01
Y-88	Not Detected	--------	3.45E-02
ZN-65	Not Detected	--------	1.02E-01
ZR-95	Not Detected	--------	5.97E-02

ER Site 147
Gamma Spectroscopy Screening Results for the Shallow Interval
Composite Soil Sample From the South Drainfield

```
**************************************************************************
*                    Sandia National Laboratories                        *
*    Radiation Protection Sample Diagnostics Program [881 Laboratory]    *
*                        1-09-95 11:24:12 AM                             *
**************************************************************************
*                                                                        *
* Analyzed by: Yvonne Cole 1/9/95      Reviewed by:  1/9/95              *
**************************************************************************
```

Customer : B.GALLOWAY/E.RANKIN (7582/SMO)
Customer Sample ID : 018878-03
Lab Sample ID : 50001903

Sample Description : MARINELLI SOLID SAMPLE
Sample Type : Solid
Sample Geometry : 1SMAR
Sample Quantity : 901.000 Gram
Sample Date/Time : 1-05-95 11:00:00 AM
Acquire Start Date : 1-07-95 1:07:17 AM
Detector Name : LAB01
Elapsed Live Time : 3600 seconds
Elapsed Real Time : 3602 seconds

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JAN 11 1995
SNL/SMO

Comments:

>>>>> NON-STANDARD SAMPLE GEOMETRY --- ALL VALUES ARE ESTIMATED.
****

Nuclide	Activity (pCi/Gram)	2S Error	MDA
U-238	8.02E-01	5.06E-01	8.68E-01
TH-234	7.85E-01	2.84E-01	3.44E-01
U-234	Not Detected	--------	3.52E+01
RA-226	1.07	3.30E-01	3.22E-01
PB-214	4.79E-01	1.30E-01	3.09E-02
BI-214	5.22E-01	8.88E-02	3.60E-02
PB-210	Not Detected	--------	3.37E+02
TH-232	4.56E-01	1.45E-01	9.35E-02
RA-228	5.26E-01	1.27E-01	1.16E-01
AC-228	5.80E-01	1.13E-01	7.21E-02
TH-228	5.21E-01	2.18E-01	3.10E-01
RA-224	4.58E-01	2.33E-01	2.80E-01
PB-212	4.65E-01	1.43E-01	2.56E-02
BI-212	4.89E-01	1.73E-01	2.34E-01
TL-208	4.82E-01	9.21E-02	4.85E-02
U-235	Not Detected	--------	1.87E-01
TH-231	~~1.93E-01~~	~~1.28E-01~~	~~2.60E-01~~ NOT Detected rec 1/9/95
PA-231	Not Detected	--------	8.19E-01
AC-227	Not Detected	--------	1.36
TH-227	Not Detected	--------	2.50E-01
RA-223	Not Detected	--------	1.53E-01
RN-219	Not Detected	--------	1.91E-01
PB-211	Not Detected	--------	4.76E-01
TL-207	Not Detected	--------	1.34E+01
AM-241	Not Detected	--------	1.92E-01
PU-239	~~1.29E+02~~	~~6.29E+01~~	~~1.38E+02~~ not Detected rec 1/9/95
NP-237	Not Detected	--------	1.66E-01
PA-233	Not Detected	--------	4.35E-02
TH-229	Not Detected	--------	2.35E-01

Section 6.9, concluded:

ER Site 147
Gamma Spectroscopy Screening Results for the Shallow Interval
Composite Soil Sample From the South Drainfield

[Summary Report] - Sample ID: 50001903

Nuclide	Activity (pCi/Gram)	2S Error	MDA
AG-110m	Not Detected	--------	2.78E-02
AR-41	Not Detected	--------	9.57E+04
BA-133	Not Detected	--------	4.57E-02
BA-140	Not Detected	--------	9.20E-02
CD-109	~~1.67E-02~~	~~3.88E-01~~	~~5.94E-01~~ not detected - mw 1/9/95
CD-115	Not Detected	--------	7.89E-02
CE-139	Not Detected	--------	2.29E-02
CE-141	Not Detected	--------	4.32E-02
CE-144	Not Detected	--------	1.88E-01
CO-56	Not Detected	--------	2.15E-02
CO-57	Not Detected	--------	2.61E-02
CO-58	Not Detected	--------	3.10E-02
CO-60	Not Detected	--------	3.83E-02
CR-51	Not Detected	--------	1.71E-01
CS-134	Not Detected	--------	3.26E-02
CS-137	Not Detected	--------	3.23E-02
CU-64	Not Detected	--------	6.66E+01
EU-152	Not Detected	--------	2.29E-01
EU-154	Not Detected	--------	1.57E-01
EU-155	Not Detected	--------	1.17E-01
FE-59	Not Detected	--------	7.22E-02
GD-153	Not Detected	--------	8.55E-02
HG-203	Not Detected	--------	2.17E-02
I-131	Not Detected	--------	2.34E-02
IN-115m	Not Detected	--------	1.87E+01
IR-192	Not Detected	--------	2.06E-02
K-40	1.77E+01	2.50	1.94E-01
LA-140	Not Detected	--------	7.04E-02
MN-54	Not Detected	--------	3.24E-02
MN-56	Not Detected	--------	1.07E+03
MO-99	Not Detected	--------	3.31E-01
NA-22	Not Detected	--------	4.34E-02
NA-24	Not Detected	--------	2.05E-01
NB-95	Not Detected	--------	1.53E-01
ND-147	Not Detected	--------	1.87E-01
NI-57	Not Detected	--------	1.09E-01
BE-7	Not Detected	--------	2.03E-01
RU-103	Not Detected	--------	2.22E-02
RU-106	Not Detected	--------	2.45E-01
SB-122	Not Detected	--------	5.14E-02
SB-124	Not Detected	--------	2.56E-02
SB-125	Not Detected	--------	6.60E-02
SC-46	Not Detected	--------	5.53E-02
SR-85	Not Detected	--------	3.00E-02
TA-182	Not Detected	--------	1.61E-01
TA-183	Not Detected	--------	2.06E-01
TE-132	Not Detected	--------	2.63E-02
TL-201	Not Detected	--------	1.25E-01
XE-133	Not Detected	--------	1.50E-01
Y-88	Not Detected	--------	3.19E-02
ZN-65	Not Detected	--------	9.91E-02
ZR-95	Not Detected	--------	5.47E-02

ER Site 147
Gamma Spectroscopy Screening Results for the Deep Interval
Composite Soil Sample From the South Drainfield

```
*************************************************************************
*                  Sandia National Laboratories                         *
*    Radiation Protection Sample Diagnostics Program [881 Laboratory]   *
*                   1-09-95 11:58:38 AM                                 *
*************************************************************************
*                                                                       *
* Analyzed by: [signature] 1/9/95   Reviewed by: [signature] 1/9/95     *
*************************************************************************
```

Customer : B.GALLOWAY/E.RANKIN (7582/SMO)
Customer Sample ID : 018879-03
Lab Sample ID : 50001904

Sample Description : MARINELLI SOLID SAMPLE
Sample Type : Solid
Sample Geometry : 1SMAR
Sample Quantity : 952.000 Gram
Sample Date/Time : 1-05-95 11:30:00 AM
Acquire Start Date : 1-07-95 2:29:26 AM
Detector Name : LAB01
Elapsed Live Time : 3600 seconds
Elapsed Real Time : 3602 seconds

RECEIVED
JAN 11 1995
SNL/SMO

Comments:

>>>>> NON-STANDARD SAMPLE GEOMETRY --- ALL VALUES ARE ESTIMATED.
****

Nuclide	Activity (pCi/Gram)	2S Error	MDA
U-238	6.87E-01	4.22E-01	8.31E-01
TH-234	6.39E-01	3.11E-01	3.19E-01
U-234	Not Detected	--------	3.39E+01
RA-226	8.68E-01	2.79E-01	3.07E-01
PB-214	4.16E-01	1.13E-01	3.09E-02
BI-214	4.62E-01	7.98E-02	3.51E-02
PB-210	Not Detected	--------	3.19E+02
TH-232	4.22E-01	1.35E-01	8.84E-02
RA-228	6.15E-01	1.37E-01	1.18E-01
AC-228	5.64E-01	1.08E-01	6.90E-02
TH-228	4.33E-01	1.93E-01	2.99E-01
RA-224	3.42E-01	1.66E-01	2.61E-01
PB-212	4.39E-01	1.35E-01	2.40E-02
BI-212	4.57E-01	1.58E-01	2.50E-01
TL-208	4.67E-01	8.91E-02	4.50E-02
U-235	Not Detected	--------	1.78E-01
TH-231	~~2.37E-01~~	~~1.34E-01~~	~~2.42E-01~~ not detected [initials]
PA-231	Not Detected	--------	7.79E-01
AC-227	Not Detected	--------	1.21
TH-227	Not Detected	--------	2.40E-01
RA-223	Not Detected	--------	1.46E-01
RN-219	Not Detected	--------	1.85E-01
PB-211	Not Detected	--------	4.49E-01
TL-207	Not Detected	--------	1.26E+01
AM-241	Not Detected	--------	1.82E-01
PU-239	Not Detected	--------	1.39E+02
NP-237	Not Detected	--------	1.55E-01
PA-233	Not Detected	--------	4.05E-02
TH-229	Not Detected	--------	2.30E-01

ER Site 147
Gamma Spectroscopy Screening Results for the Deep Interval
Composite Soil Sample From the South Drainfield

[Summary Report] - Sample ID: 50001904

Nuclide	Activity (pCi/Gram)	2S Error	MDA
AG-110m	Not Detected	--------	2.55E-02
AR-41	Not Detected	--------	1.32E+05
BA-133	Not Detected	--------	4.22E-02
BA-140	Not Detected	--------	8.94E-02
CD-109	Not Detected	--------	5.52E-01
CD-115	Not Detected	--------	7.62E-02
CE-139	Not Detected	--------	2.16E-02
CE-141	Not Detected	--------	4.20E-02
CE-144	Not Detected	--------	1.83E-01
CO-56	Not Detected	--------	2.09E-02
CO-57	Not Detected	--------	2.47E-02
CO-58	Not Detected	--------	2.95E-02
CO-60	Not Detected	--------	3.63E-02
CR-51	Not Detected	--------	1.64E-01
CS-134	Not Detected	--------	2.98E-02
CS-137	Not Detected	--------	3.01E-02
CU-64	Not Detected	--------	6.10E+01
EU-152	Not Detected	--------	2.17E-01
EU-154	Not Detected	--------	1.46E-01
EU-155	Not Detected	--------	1.17E-01
FE-59	Not Detected	--------	6.82E-02
GD-153	Not Detected	--------	8.24E-02
HG-203	Not Detected	--------	1.96E-02
I-131	Not Detected	--------	2.38E-02
IN-115m	Not Detected	--------	2.04E+01
IR-192	Not Detected	--------	1.89E-02
K-40	1.66E+01	2.38	1.83E-01
LA-140	Not Detected	--------	6.67E-02
MN-54	Not Detected	--------	3.11E-02
MN-56	Not Detected	--------	1.30E+03
MO-99	Not Detected	--------	3.30E-01
NA-22	Not Detected	--------	4.19E-02
NA-24	Not Detected	--------	1.95E-01
NB-95	Not Detected	--------	1.48E-01
ND-147	Not Detected	--------	1.66E-01
NI-57	Not Detected	--------	1.01E-01
BE-7	Not Detected	--------	1.95E-01
RU-103	Not Detected	--------	2.06E-02
RU-106	Not Detected	--------	2.25E-01
SB-122	Not Detected	--------	4.74E-02
SB-124	Not Detected	--------	2.42E-02
SB-125	Not Detected	--------	6.36E-02
SC-46	Not Detected	--------	4.95E-02
SR-85	Not Detected	--------	2.97E-02
TA-182	Not Detected	--------	1.45E-01
TA-183	Not Detected	--------	1.96E-01
TE-132	Not Detected	--------	2.58E-02
TL-201	Not Detected	--------	1.20E-01
XE-133	Not Detected	--------	1.46E-01
Y-88	Not Detected	--------	3.28E-02
ZN-65	Not Detected	--------	9.23E-02
ZR-95	Not Detected	--------	5.34E-02

6.11 Risk Assessment Analysis

6.11.1 Site Description and History

ER Site 147 is located in Coyote Test Field in the southern part of KAFB, approximately 1.5 miles north of the Isleta Pueblo boundary and 0.25 miles east of Lovelace Road. The site is also located about 1.1 miles northeast of the Solar Power Tower (SPT), a prominent landmark in the area.

ER Site 147 consists of two adjacent but separate areas. The first area encompasses two septic tank and drainfield systems north and west of Building 9925, and the second area includes a third septic tank and drainfield system south of Building 9925 that is now under the asphalt pavement of Optical Range Road. These two areas encompass approximately 0.58 acres of essentially flat-lying land at an average mean elevation of 5,701 feet above mean sea level (amsl).

Building 9925 was built in 1959 and functioned as the Coyote Test Field Headquarters from 1968 until around 1991. Little information was available concerning the early operational history. Interviews with personnel familiar with the facility indicated that Building 9925 is located at the north end of the former Area Y, one of three primary explosive test areas in the 1950s. It was also referred to as the Moonlight Shot Area, which involved the firing of mock weapons and weapon components constructed of depleted uranium. A machine shop in the north end of the building occasionally used small quantities of solvents, but there is no history of discharges to the septic systems.

There are two restrooms with floor drains and two showers in Bldg. 9925. There is no floor drain in the machine shop. An SNL/NM Facilities Engineering drawing with the earliest legible date of June 1982 shows the south system to have consisted of a 750 gallon septic tank and an associated drainfield composed of two parallel drainlines that are 70 feet long and 10 feet apart. The drawing shows that the south system components are located south of Building 9925, under the pavement of Optical Range Road. This same drawing shows the south system as "abandoned in place." The septic tank was found to be filled with soil when the ER Site 147 septic tanks were first sampled in 1992. It is assumed that the south system tank was filled with soil around June 1982. A second abandoned septic system (the west system) is located about 150 feet northwest of Building 9925, and consists of a 1,500 gallon septic tank that was connected to a drainfield composed of six 40-foot long parallel distribution lines. The third (north) system septic tank and drainfield were installed to replace the other two systems. Another SNL/NM Facilities Engineering drawing dated August 20, 1980 shows the planned construction configuration for the new north system, so it is assumed that it was installed, and the west system was abandoned, in approximately the fall of 1980. The north system tank was installed immediately northwest of and in line with the west system tank, and was plumbed to a drainfield composed of six 50-foot long parallel drainlines. This drainfield is located about 250 feet north of Building 9925, outside of the facility perimeter fence. Estimated effluent volumes for the abandoned systems range from 100 to 4,000 gallons per day. The north system is also no longer used. Building 9925, as of June 1991, was connected to an extension of the City of Albuquerque sanitary sewer system.

6.11.2 Risk Assessment Analysis

Risk assessment of this site includes a number of steps which culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents located at the site. The steps to be discussed include:

Step 1.	Site data are described which provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site.
Step 2.	Potential pathways by which a representative population might be exposed to the COCs are identified.
Step 3.	The potential intake of these COCs by the representative population is calculated using a tiered approach. The tiered approach includes screening steps, followed by potential intake calculations and a discussion or evaluation of the uncertainty in those calculations. Potential intake calculations are also applied to background screening data.
Step 4.	Data are described on the potential toxicity and cancer effects from exposure to the COCs and associated background constituents and subsequent intake.
Step 5.	Potential toxicity effects (specified as a Hazard Index) and cancer risks are calculated for nonradiological COCs and background. For radiological COCs, the incremental total effective dose equivalent (TEDE) and incremental estimated cancer risk are calculated by subtracting applicable background concentrations directly from maximum on-site contaminant values. This background subtraction only occurs when a radiological COC occurs as contamination and exists as a natural background radionuclide
Step 6.	These values are compared with standards established by the United States (U.S.) Environmental Protection Agency (USEPA) and U.S. Department of Energy (USDOE) to determine if further evaluation, and potential site clean-up, is required. Nonradiological COC risk values are also compared to background risk so that an incremental risk may be calculated.
Step 7.	Discussion of uncertainties in the previous steps.

6.11.2.1 Step 1. Site Data

Site history and characterization activities are used to identify potential COCs. The identification of COCs and the sampling to determine the concentration levels of those COCs across the site are described in the ER Site 147 No Further Action (NFA) proposal. In order to provide conservatism in this risk assessment, the calculation uses only the maximum concentration value of each COC determined for the entire site. Both radioactive and nonradioactive COCs are evaluated. The only nonradioactive COCs evaluated are metals because VOCs were either non-detect or were determined to be lab contamination.

6.11.2.2 Step 2. Pathway Identification

ER Site 147 has been designated with a future land-use scenario of industrial (see Attachment 1 for default exposure pathways and parameters). Because of the location and the

characteristics of the potential contaminants, the primary pathway for human exposure to nonradiological COCs is considered to be soil ingestion. For radiological COCs the primary pathway for human exposure is inhalation for the industrial land-use scenario and plant ingestion for the residential land-use scenario. The inhalation pathway for metals is included because of the potential to inhale dust. It is included for radionuclides because of the potential to inhale dust and volatiles. Direct gamma exposure is not included in the radioactive contamination risk assessment as the only radiological COC in excess of background was non-gamma emitting. No contamination at depth was determined and therefore no water pathways to the groundwater are considered. Depth to groundwater at Site 147 is greater than 23 feet, but less than 100 feet. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered to not be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the industrial land-use scenario. However, plant uptake is considered for the residential land-use scenario.

Pathway Identification

Chemical Constituents	Radionuclide Constituents
Soil Ingestion	Soil Ingestion
Inhalation (Dust)	Inhalation (Dust and Volatiles)
Plant uptake (Residential only)	Plant uptake (Residential only)

6.11.2.3 Steps 3-5. Calculation of Hazard Indices and Cancer Risks

Steps 3 through 5 are discussed in this section. These steps include the discussion of the tiered approach in eliminating potential COCs from further consideration in the risk assessment process and the calculation of intakes from all identified exposure pathways, the discussion of the toxicity information, and the calculation of the hazard indices and cancer risks.

The risks from the COCs at ER Site 147 were evaluated using a tiered approach. The maximum concentrations of COCs were compared to the SNL/NM background screening level for this area (IT, 1996). If a SNL/NM-specific screening level was not available for a constituent, then a background value was obtained, when possible, from the U.S. Geological Survey (USGS) National Uranium Resource Evaluation (NURE) program (USGS, 1994). For the purpose of this investigation the background for tritium in soil moisture was assumed to be represented by samples taken by the EPA of rainwater throughout the United States (USEPA, 1993). Assuming that the atmospheric tritium concentration in this rainwater is in equilibrium with tritium in soil moisture this background range used is 100 - 400 pCi/liter (pCi/l) of soil moisture.

The maximum concentration of each COC was used in order to provide a conservative estimate of the associated risk. If any nonradiological COCs were above the SNL/NM background screening levels or the USGS background value, all nonradiological COCs were considered in further risk assessment analyses.

For radiological COCs that exceeded both the SNL/NM background screening levels and, as applicable, were above the EPA background tritium range, background values were subtracted

from the individual maximum radionuclide concentrations. Those that did not exceed these background levels were not carried any further in the risk assessment. This approach is consistent with USDOE orders.

Radioactive COCs that did not have a background value and were detected above the analytical minimum detectable activity (MDA) were carried through the risk assessment at their maximum levels. This step is performed (rather than carry the below-background radioactive COCs through the risk assessment and then perform a background risk assessment to determine incremental TEDE and estimated cancer risk) to prevent the "masking" of radiological contamination that may occur if on-site background radiological COCs exist in concentrations far enough below the assigned background level. When this "masking" occurs, the final incremental TEDE and estimated cancer risk are reduced and, therefore, provide a non-conservative estimate of the potential impact on an on-site receptor. This approach is also consistent with the regulatory approach (40 CFR Part 196, 1994) which sets a TEDE limit to the on-site receptor in excess of background. The resultant radioactive COCs remaining after this step are referred to as background-adjusted radioactive COCs.

Next, the remaining maximum concentration for each remaining nonradiological COC was compared with action levels calculated using methods and equations promulgated in the proposed Resource Conservation and Recovery Act (RCRA) Subpart S (40 CFR Part 264, 1990) and Risk Assessment Guidance for Superfund (RAGS) (USEPA, 1989) documentation. Accordingly, all calculations were based on the assumption that receptor doses from both toxic and potentially carcinogenic compounds result most significantly from ingestion of contaminated soil. Because the samples were collected below ground surface, this assumption is conservative. If there are 10 or fewer COCs and each has a maximum concentration less than one-tenth of the action level, then the site would be judged to pose no significant health hazard to humans. If there are more than 10 COCs, the Subpart S screening procedure was skipped.

Third, hazard indices and risk due to carcinogenic effects were calculated using Reasonable Maximum Exposure (RME) methods and equations promulgated in RAGS (USEPA, 1989). The combined effects of all nonradiological COCs in the soils were calculated. The combined effects of all associated nonradiological background constituents in the soils were also calculated. For toxic compounds, this was accomplished by summing the individual hazard quotients for each compound into a total Hazard Index. This Hazard Index is compared to the recommended standard of 1. For potentially carcinogenic compounds, the individual risks were summed. The total risk was compared to the recommended acceptable risk range of 10^{-4} to 10^{-6} For the radioactive COCs, the incremental TEDE was calculated and the corresponding incremental cancer risk estimated using USDOE's RESRAD computer code.

6.11.2.3.1 Comparison to Background and Action Levels

Nonradioactive ER Site 147 COCs are listed in Table 6-1; radioactive COCs are listed in Table 6-2. Both tables show the associated 95th percentile or UTL background levels (IT, 1996). The SNL/NM background levels have not yet been approved by the USEPA or the NMED but are the result of a comprehensive study of joint SNL/NM and U.S. Air Force data from the Kirtland Air Force Base (KAFB). The report was submitted for regulatory review in

early 1996. The values shown in Table 6-1 supersede the background values described in an interim background study report (IT, 1994). Several compounds have maximum measured values greater than background screening levels. Therefore all nonradiological COCs were retained for further analysis with the exception of lead. The maximum concentration value for lead is 39.7 mg/kg. The USEPA intentionally does not provide any toxicological data on lead and therefore no risk parameter values can be calculated. However, EPA guidance for the screening value for lead for an industrial land-use scenario is 2000 mg/kg (EPA, 1996a); for a residential land-use scenario, the EPA screening guidance value is 400 mg/kg (EPA, 1994a). The maximum concentration value for lead at this site is less than both of those screening values and therefore lead is eliminated from further consideration in this risk assessment.

Because several nonradiological COCs had concentrations greater than their respective SNL/NM background 95th percentile or UTL, the site fails the background screening criteria and all nonradiological COCs proceed to the proposed Subpart S action level screening procedure. Table 6-3 shows the inorganic COCs. The table also shows the proposed Subpart S action level for the contaminants. The table compares the maximum concentration values to 1/10 of the proposed Subpart S action level. This methodology was guidance given to SNL/NM from the USEPA (USEPA, 1996b). This is the second screening process in the tiered risk assessment approach. One nonradioactive compound (arsenic) had a concentration value greater than 1/10 of the proposed Subpart S action level. Because of arsenic, the site fails the proposed Subpart S screening criteria and a Hazard Index value and cancer risk value must be calculated for the eight nonradioactive contaminants.

Radioactive contaminants do not have pre-determined action levels analogous to the proposed Subpart S and therefore this step in the screening process is not performed for radionuclides.

6.11.2.3.2 Identification of Toxicological Parameters

Tables 6-4 and 6-5 show the COCs that have been retained in the risk assessment and the values for the toxicological information available for those COCs. Dose conversion factors (DCFs) used in determining the incremental TEDE values for the individual pathways were the default values provided in the RESRAD computer code as developed in the following:

- For ingestion and inhalation, DCFs are taken from Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion* (USEPA, 1988a).

- The DCFs for surface contamination (contamination on the surface of the site) were taken from USDOE/EH-0070, *External Dose-Rate Conversion Factors for Calculation of Dose to the Public* (USDOE, 1988).

- The DCFs for volume contamination (exposure to contamination deeper than the immediate surface of the site) were calculated using the methods discussed in, *Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil* (Health Physics 28:193-205) (Kocher, D.C., 1983), and ANL/EAIS-8, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil* (Yu, C., et al., 1993b).

Table 6-1
Nonradioactive COCs at ER Site 147 and Comparison to the Background Screening Values

COC name	Maximum concentration (mg/kg)	SNL/NM 95th % or UTL Level (mg/kg)	Is maximum COC concentration less than or equal to the applicable SNL/NM background screening value?
Arsenic	6.9	7	Yes
Barium	355	214	**No**
Cadmium	<0.5	0.9	Yes
Chromium, total	7.8	15.9	Yes
Lead	39.7	11.8	**No**
Mercury	<0.1	<0.1	**No^**
Selenium	<0.5	<1.0	**No^**
Silver	0.44 J	<1.0	**No^**
TNT	<1	NC	**No**

J - estimated value
^ uncertainty due to detection limits
NC - not calculated

Table 6-2
Radioactive COCs at ER Site 147 and Comparison to the Background Screening Values

COC name	Maximum concentration (pCi/g)	SNL/NM 95th % or UTL Level (pCi/g)	Is maximum COC concentration less than or equal to the applicable SNL/NM background screening value?
H-3	450 B (pCi/l)	100 - 400 pCi/l	No
U-238	1.3	1.4	Yes
U-235	0.072	0.16	Yes
U-233/234	1.3	1.4	Yes

*Assuming 10 wt% soil moisture, pCi/g = pCi/l x 1E-04
** Background value provided as "<5.02", therefore background U-234 is assumed to be equal to that of it's parent radionuclide, U-238, as they would exist in secular equilibrium in their naturally-occurring state.
B - parameter detected in method blank

Table 6-3
Comparison of ER Site 147 Nonradioactive COC Concentrations to
Proposed Subpart S Action Levels

COC name	Maximum concentration (mg/kg)	Proposed Subpart S Action Level (mg/kg)	Is individual contaminant less than 1/10 the Action Level?
Arsenic	6.9	0.5	**No**
Barium	355	6000	Yes
Cadmium	<0.5	80	Yes
Chromium, total*	7.8	400	Yes
Mercury	<0.1	20	Yes
Selenium	<0.5	400	Yes
Silver	0.44 J	400	Yes
TNT	<1	40	Yes

* total chromium assumed to be chromium VI (most conservative)
J - estimated value

Table 6-4
Nonradioactive Toxicological Parameter Values for ER Site 147 COCs

COC name	RfD_o (mg/kg/d)	RfD_{inh} (mg/kg/d)	Confidence	SF_o (kg-d/mg)	SF_{inh} (kg-d/mg)	Cancer Class ^
Arsenic	0.0003	--	M	1.5	15.1	**A**
Barium	0.07	0.000143	M	--	--	**D**
Cadmium	0.0005	0.0000571	H	--	6.3	**B1**
Chromium, total*	0.005	--	L	--	42	**A**
Mercury	0.0003	0.0000857	--	--	--	**D**
Selenium	0.005	--	H	--	--	**D**
Silver	0.005	--	--	--	--	**D**
TNT	0.0005	--	M	0.03	--	**C**

* total chromium assumed to be chromium VI (most conservative)
RfD_o - oral chronic reference dose in mg/kg-day
RfD_{inh} - inhalation chronic reference dose in mg/kg-day
Confidence - L = low, M = medium, H = high
SF_o - oral slope factor in $(mg/kg\text{-}day)^{-1}$
SF_{inh} - inhalation slope factor in $(mg/kg\text{-}day)^{-1}$
^ EPA weight-of-evidence classification system for carcinogenicity:
A - human carcinogen
B1 - probable human carcinogen. Limited human data are available
B2 - probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
C - possible human carcinogen
D - not classifiable as to human carcinogenicity
E - evidence of noncarcinogenicity for humans
-- information not available

Table 6-5
Radiological Toxicological Parameter Values for ER Site 147 COCs

COC name	SF_{ev} (g/pCi-yr)	SF_{o} (1/pCi)	SF_{inh} (1/pCi)	Cancer Class^
H-3	0	7.2E-14	9.6E-14	**A**

Sf_{ev}- external volume exposure slope factor (risk/yr per pCi/g)
SF_{o} - oral (ingestion) slope factor (risk/pCi)
SF_{inh} - inhalation slope factor (risk/pCi)
^ EPA weight-of-evidence classification system for carcinogenicity:

A - human carcinogen
B1 - probable human carcinogen. Limited human data are available
B2 - probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
C - possible human carcinogen
D - not classifiable as to human carcinogenicity

E - evidence of noncarcinogenicity for humans

6.11.2.3.3 Exposure Assessment and Risk Characterization

Section 6.11.3.3.1 describes the exposure assessment for this risk assessment.
Section 6.11.3.3.2 provides the risk characterization including the Hazard Index value and the excess cancer risk for both the potential nonradiological COCs and associated background; industrial and residential land-uses. The incremental TEDE and incremental estimated cancer risk are provided for the background-adjusted radiological COCs; industrial and residential land-uses.

Exposure Assessment

Attachment 1 shows the equations and parameter values used in the calculation of intake values and the subsequent Hazard Index and excess cancer risk values for the individual exposure pathways. The appendix shows the parameters for both industrial and residential land-use scenarios. The equations are based on RAGS (USEPA, 1989). The parameters are based on information from RAGS (USEPA, 1989) as well as other USEPA guidance documents and reflect the RME approach advocated by RAGS (USEPA, 1989). For radionuclides, the coded equations provided in the RESRAD computer code were used to estimate the excess dose and cancer risk for the individual exposure pathways. Further discussion of this process is provided in Manual for

Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0 (Yu, C., et al., 1993a).

Although the designated land-use scenario is industrial for this site, the risk and TEDE values for a residential land-use scenario are also presented. These residential risk and TEDE values

are presented to only provide perspective of the potential for risk to human health under the more restrictive land-use scenario.

Risk Characterization

Table 6-6 shows that for the ER Site 147 nonradioactive COCs, the Hazard Index value is 0.03 and the excess cancer risk is 4×10^{-6} for the designated industrial land-use scenario. The numbers presented included exposure from soil ingestion and dust inhalation for the nonradioactive COCs. Table 6-7 shows that for the ER Site 147 associated background constituents, the Hazard Index is 0.02 and the excess cancer risk is 4×10^{-6} for the designated industrial land-use scenario.

For the radiological COCs the TEDE for industrial land-use is 1×10^{-5} mrem/yr. In accordance with proposed USEPA guidance, the standard being utilized is an incremental TEDE of 15 mrem/yr (40 CFR Part 196, 1994) for the probable land-use scenario (industrial in this case); the calculated dose value for ER Site 147 for the industrial land-use is well below this standard.

For the residential land-use scenario, the Hazard Index value increases to 1 and the excess cancer risk is 8×10^{-5}. The numbers presented included exposure from soil ingestion, dust inhalation, and plant uptake. Although USEPA (1991) generally recommends that inhalation not be included in a residential land-use scenario, this pathway is included because of the potential for soil in Albuquerque, NM, to be eroded and, subsequently, for dust to be present even in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Attachment 1). Table 6-7 shows that for the ER Site 147 associated background constituents, the Hazard Index increases to 1 and the excess cancer risk is 8×10^{-5}.

For the radiological COCs the TEDE for the residential land-use is 2×10^{-4} mrem/yr. In accordance with proposed USEPA guidance, the standard being utilized is an incremental TEDE of 75 mrem/yr (40 CFR Part 196, 1994) for a complete loss of institutional controls (residential land-use in this case); the calculated dose values for ER Site 147 for the residential land-use is well below this standard. It should also be noted that, consistent with the proposed guidance (40 CFR Part 196, 1994), ER Site 147 should be eligible for unrestricted radiological release as the residential scenario resulted in an incremental TEDE to the on-site receptor of less than 15 mrem/yr.

The excess cancer risk from the nonradioactive COCs and the radioactive COCs is not additive, as noted in RAGS (USEPA, 1989).

6.11.2.4 Step 6. Comparison of Risk Values to Numerical Standards.

The risk assessment analyses considered the evaluation of the potential for adverse health effects for both an industrial land-use scenario, which is the designated land-use scenario for this site, and also a residential land-use scenario.

Table 6-6
Nonradioactive Risk Assessment Values for ER Site 147 COCs

COC Name	Maximum concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	6.9	0.02	4E-6	0.39	8E-5
Barium	355	0.01	--	0.05	--
Cadmium	<0.5	0.00	2E-10	0.41	3E-10
Chromium, total*	7.8	0.00	2E-8	0.01	3E-8
Mercury	<0.1	0.00	--	0.17	--
Selenium	<0.5	0.00	--	0.18	--
Silver	0.44 J	0.00	--	0.02	--
TNT	<1	0.00	1E-8	0.01	5E-8
TOTAL		**0.03**	**4E-6**	**1**	**8E-5**

* total chromium assumed to be chromium VI (most conservative)
-- information not available
J - estimated value

Table 6-7
Nonradioactive Risk Assessment Values for ER Site 147 Background Constituents

Constituent Name	Background concentration (mg/kg)	Industrial Land- Use Scenario		Residential Land- Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	7	0.02	4E-6	0.4	8E-5
Barium	214	0.00	--	0.03	--
Cadmium	0.9	0.00	4E-10	0.74	5E-10
Chromium, total*	<2.5	--	--	--	--
Mercury	<0.1	--	--	--	--
Selenium	<1.0	--	--	--	--
Silver	<1.0	--	--	--	--
TOTAL		**0.02**	**4E-6**	**1**	**8E-5**

* total chromium assumed to be chromium VI (most conservative)
-- information not available
J - estimated value

For the industrial land-use scenario, the Hazard Index calculated is 0.03; this is much less than the numerical standard of 1 suggested in RAGS (USEPA, 1989). The excess cancer risk is estimated at 4×10^{-6}. In RAGS, the USEPA suggests that a range of values (10^{-6} to 10^{-4}) be used as the numerical standard; the value calculated for this site is in the low end of the suggested acceptable risk range. Therefore, for an industrial land-use scenario, the Hazard Index risk assessment values are significantly less than the established numerical standards and the excess cancer risk for the nonradiological COCs is in the low end of the suggested acceptable risk range. This risk assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the industrial and residential land-use scenarios. For the industrial land-use scenario, the Hazard Index is 0.02. The excess cancer risk is estimated at 4×10^{-6}. Incremental risk is determined from subtracting risk associated with background from potential nonradiological COC risk. These numbers are not rounded before the difference is determined and therefore may appear to be inconsistent with numbers presented in tables and discussed within the text. The incremental Hazard Index is 0.01, there is no incremental cancer risk for the industrial land-use scenario.

For the radioactive components of the industrial land-use scenario, the calculated incremental TEDE is 1×10^{-5} mrem/yr, which is significantly less than the numerical standard of 15 mrem/yr suggested in the draft USEPA guidance. The excess cancer risk estimate is 5×10^{-10}.

For the residential land-use scenario, the calculated Hazard Index is 1, which is at the numerical guidance. The excess cancer risk is estimated at 8×10^{-5}; this value is at the upper end of the suggested acceptable risk range. The Hazard Index for associated background for the residential land-use scenario is 1. The excess cancer risk is estimated at 8×10^{-5}. For the residential land-use scenario, the incremental Hazard Index is 0.07; there is no incremental cancer risk. The incremental TEDE from the radioactive components is 2×10^{-4} mrem/yr, which is significantly less than the numerical guidance. The associated cancer risk is 6×10^{-9}, slightly higher than for the industrial land-use scenario but still significantly below background calculated risk values.

6.11.2.5 Step 7 Uncertainty Discussion

The conclusion from the risk assessment analysis is that the potential effects caused by potential nonradiological COCs on human health are within the acceptable range compared to established numerical standards for the industrial land-use scenario. Calculated incremental risk between potential nonradiological COCs and associated background indicate little risk from nonradiological COCs when considering the industrial land-use scenario.
The main contributor to the adverse effects on human health from nonradiological COCs is arsenic (6.9 mg/kg). Arsenic was below the respective background screening level. Therefore, this risk assessment is considered conservative as arsenic is probably not indicative of contamination.

For the radiological COCs the conclusion from the risk assessment is that the potential effects on human health, for the industrial land-use scenario, is well within proposed standards (40 CFR Part 196, 1994) and is a small fraction of the estimated 290 mrem/yr received due to natural background (NCRP, 1987).

The potential effects on human health, for nonradiological COCs, are greater when considering the residential land-use scenario. However, calculated incremental risk between potential nonradiological COCs and associated background indicate little risk from nonradiological COCs when considering the residential. The increased effects on human health are primarily the result of including the plant uptake exposure pathway. Constituents that posed little to no risk considering an industrial land-use scenario (some of which are below background screening levels), contribute a significant portion of the risk associated with the residential land-use scenario. These constituents bioaccumulate in plants. Because ER Site 147 is an industrial site, the likelihood of significant plant uptake in this area is highly unlikely. The uncertainty in this conclusion is considered to be small.

For the radiological COCs the conclusion from the risk assessment is that the potential effects on human health, for the residential land-use scenario, is well within proposed standards (40 CFR Part 196, 1994) and is a small fraction of the estimated 290 mrem/yr received due to natural background (NCRP, 1987).

Because of the location, history of the site and the future land-use (USDOE, 1996), there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in making the risk assessment analysis. Because the COCs are found in subsurface soils and because of the location and physical characteristics of the site, the exposure pathways relevant to the analysis are conservative. For example, considering the industrial land-use scenario, the soil ingestion pathway results are very conservative as a worker contacting the soil at depth would be likely involved in construction and would contact the soil for only a short time instead of 30 years.

The approach taken in determining potential effects on human health due to the radiological COCs is particularly conservative in that it was assumed that all radiological constituents existed in the upper six inches of the soil layer, rather than in the subsurface near the tank.

An RME approach was used to calculate the risk assessment values, which means that the parameter values used in the calculations were conservative and that the calculated intakes are likely overestimates. Maximum measured values of the concentrations of the COCs and minimum value of the 95th UTL or percentile concentration value, as applicable, of background concentrations associated with the COCs were used to provide conservative results.

Table 6-4 shows the uncertainties (confidence) in the nonradiological toxicological parameter values. There is a mixture of estimated values and values from the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1996c) and Integrated Risk Information System (IRIS) (USEPA, 1988, 1994b) databases. Because of the conservative nature of the RME approach, the uncertainties in the toxicological values are not expected to be of high enough concern to change the conclusion from the risk assessment analysis.

The nonradiological risk assessment values are within the acceptable range for the industrial land-use scenario compared to the established numerical standards. Though the residential land-use Hazard Index is at the numerical standard, it has been determined that future land-use at this locality will not be residential (USDOE, 1996). The radiological incremental TEDE is a very small fraction of estimated background TEDE for both the industrial and residential land-use scenarios and both are well within proposed standards (40 CFR Part 196, 1994). The

overall uncertainty in all of the steps in the risk assessment process is considered not significant with respect to the conclusion reached.

6.11.3 Summary

ER Site 147 had relatively minor contamination consisting of some inorganic and radioactive compounds. Because of the location of the site on KAFB, the designated industrial land-use scenario and the nature of the contamination, the potential exposure pathways identified for this site included soil ingestion and dust inhalation for chemical constituents and soil ingestion, dust and volatile inhalation. These exposure pathways are very conservative as a worker contacting the soil at depth would likely be involved in construction and would contact the soil for only a short time instead of 30 years.

The residential land-use scenario includes the soil ingestion, inhalation, and plant uptake exposure pathways. Because the small amount of contamination present is below ground surface, the potential for exposure from soil ingestion and inhalation of surface dust is not significant. Likewise, plant uptake will generally occur near surface. Because the site is designated as industrial and the residential land-use scenario is provided to only provide perspective, the stated exposure pathways were included but provide a conservative risk assessment.

The main contributors to the industrial land-use scenario radiological risk assessment values is arsenic (6.9 mg/kg). Arsenic was below the respective background screening level. Therefore, this risk assessment is considered conservative as arsenic is probably not indicative of contamination.

Using conservative assumptions and employing a RME approach to the risk assessment, the calculations for the nonradiological COCs show that for the industrial land-use scenario the Hazard Index (0.03) is significantly less than the accepted numerical guidance from the USEPA. The estimated cancer risk (4×10^{-6}) is in the low end of the suggested acceptable risk range. The incremental Hazard Index is 0.01 for the industrial land-use scenario; there is no incremental cancer risk.

The incremental TEDE and corresponding estimated cancer risk from the radioactive components are much less than USEPA guidance values; the estimated dose is 1×10^{-5} mrem/yr for the industrial land-use scenario. This value is much less than the numerical guidance of 15 mrem/yr in draft USEPA guidance. The corresponding estimated cancer risk value is 5×10^{-10} for the industrial land-use scenario.

The calculations show that for the residential land-use scenario the Hazard Index (1) is at the accepted numerical guidance from the USEPA. The estimated cancer risk (8×10^{-5}) is at the upper end of the suggested acceptable risk range. The increased effects on human health are primarily the result of the inclusion of the plant uptake exposure pathway. Constituents that posed little to no risk considering an industrial land-use scenario (some of which are below background screening levels), contribute a significant portion of the risk associated with the residential land-use scenario. These constituents bioaccumulate in plants. Because ER Site

147 is an industrial site (USDOE, 1996), the likelihood of significant plant uptake in this area is highly unlikely. Also, the contamination occurs at depth, below typical plant root zones. The incremental Hazard Index for the residential land-use scenario is 0.07; there is no incremental cancer risk for the residential land-use scenario. Increased risk from the COCs was evident considering residential land-use, due to plant uptake, but future use will be restricted to industrial land-use (USDOE, 1996).

The incremental TEDE and corresponding estimated cancer risk from the radioactive components are much less than USEPA guidance values; the estimated dose is 2×10^{-4} mrem/yr for the residential land-use scenario. This value is much less than the numerical guidance of 75 mrem/yr in draft USEPA guidance. The corresponding estimated cancer risk value is 6×10^{-9} for the residential land-use scenario.

The uncertainties associated with the calculations are considered small relative to the conservativeness of the risk assessment analysis. We therefore conclude that this site does not have significant potential to affect human health under either an industrial or residential land-use scenario.

Ecological Risk Assessment

The ecological risk for this site has not been estimated at this time. SNL/NM ecological risk analyses are being conducted and the relevant analysis for this site will be presented when available.

6.11.4 References

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ATTACHMENT 1.

Sandia National Laboratories Environmental Restoration Program

EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

BACKGROUND

Sandia National Laboratories (SNL) proposes that a default set of exposure routes and associated default parameter values be developed for each future land-use designation being considered for SNL/NM Environmental Restoration (ER) project sites. This default set of exposure scenarios and parameter values would be invoked for risk assessments unless site-specific information suggested other parameter values. Because many SNL/NM ER sites have similar types of contamination and physical settings, SNL believes that the risk assessment analyses at these sites can be similar. A default set of exposure scenarios and parameter values will facilitate the risk assessments and subsequent review.

The default exposure routes and parameter values suggested are those that SNL views as resulting in a Reasonable Maximum Exposure (RME) value. Subject to comments and recommendations by the USEPA Region VI and NMED, SNL proposes that these default exposure routes and parameter values be used in future risk assessments.

At SNL/NM, all Environmental Restoration sites exist within the boundaries of the Kirtland AFB. Approximately 157 potential waste and release sites have been identified where hazardous, radiological, or mixed materials may have been released to the environment. Evaluation and characterization activities have occurred at all of these sites to varying degrees. Among other documents, the SNL/ER draft Environmental Assessment (DOE, 1996) presents a summary of the hydrogeology of the sites, the biological resources present and proposed land use scenarios for the SNL/NM ER sites. At this time, all SNL/NM ER sites have been tentatively designated for either industrial or recreational future land use. The NMED has also requested that risk calculations be performed based on a residential land use scenario. All three land use scenarios will be addressed in this document.

The SNL/NM ER project has screened the potential exposure routes and identified default parameter values to be used for calculating potential intake and subsequent hazard index, risk and dose values. EPA (EPA, 1989a) provides a summary of exposure routes that could potentially be of significance at a specific waste site. These potential exposure routes consist of:

- Ingestion of contaminated drinking water;
- Ingestion of contaminated soil;
- Ingestion of contaminated fish and shell fish;
- Ingestion of contaminated fruits and vegetables;
- Ingestion of contaminated meat, eggs, and dairy products;
- Ingestion of contaminated surface water while swimming;

- Dermal contact with chemicals in water;
- Dermal contact with chemicals in soil;
- Inhalation of airborne compounds (vapor phase or particulate), and;
- External exposure to penetrating radiation (immersion in contaminated air; immersion in contaminated water and exposure from ground surfaces with photon-emitting radionuclides).

Based on the location of the SNL ER sites and the characteristics of the surface and subsurface at the sites, we have evaluated these potential exposure routes for different land use scenarios to determine which should be considered in risk assessment analyses (the last exposure route is pertinent to radionuclides only). At SNL/NM ER sites, there does not presently occur any consumption of fish, shell fish, fruits, vegetables, meat, eggs, or dairy products that originate on-site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL, 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

For the industrial and recreational land use scenarios, SNL/NM ER has therefore excluded the following four potential exposure routes from further risk assessment evaluations at any SNL/NM ER site:

- Ingestion of contaminated fish and shell fish;
- Ingestion of contaminated fruits and vegetables;
- Ingestion of contaminated meat, eggs, and dairy products; and
- Ingestion of contaminated surface water while swimming.

That part of the exposure pathway for radionuclides related to immersion in contaminated air or water is also eliminated.

For the residential land-use scenario, we will include ingestion of contaminated fruits and vegetables because of the potential for residential gardening.

Based on this evaluation, for future risk assessments, the exposure routes that will be considered are shown in Table 1. Dermal contact is included as a potential exposure pathway in all land use scenarios. However, the potential for dermal exposure to inorganics is not considered significant and will not be included. In general, the dermal exposure pathway is generally considered to not be significant relative to water ingestion and soil ingestion pathways but will be considered for organic components. Because of the lack of toxicological parameter values for this pathway, the inclusion of this exposure pathway into risk assessment calculations may not be possible and may be part of the uncertainty analysis for a site where dermal contact is potentially applicable.

Table 1. Exposure Pathways Considered for Various Land Use Scenarios

Industrial	Recreational	Residential
Ingestion of contaminated drinking water	Ingestion of contaminated drinking water	Ingestion of contaminated drinking water
Ingestion of contaminated soil	Ingestion of contaminated soil	Ingestion of contaminated soil
Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)
Dermal contact	Dermal contact	Dermal contact
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	Ingestion of fruits and vegetables
		External exposure to penetrating radiation from ground surfaces

EQUATIONS AND DEFAULT PARAMETER VALUES FOR IDENTIFIED EXPOSURE ROUTES

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land use scenarios. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for Superfund (RAGS): Volume 1 (EPA, 1989a and 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL, 1993). Also shown are the default values SNL/NM ER suggests for use in Reasonable Maximum Exposure (RME) risk assessment calculations for industrial, recreational, and residential scenarios, based on EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL, 1993).

Generic Equation for Calculation of Risk Parameter Values

The equation used to calculate the risk parameter values (i.e., Hazard Quotient/Index, excess cancer risk, or radiation total effective dose equivalent [dose]) is similar for all exposure pathways and is given by:

Risk (or Dose) = Intake x Toxicity Effect (either carcinogenic, noncarcinogenic, or radiological)

$$= C \times (CR \times EFD/BW/AT) \times \text{Toxicity Effect} \qquad (1)$$

where

C = contaminant concentration (site specific);
CR = contact rate for the exposure pathway;
EFD = exposure frequency and duration;
BW = body weight of average exposure individual;
AT = time over which exposure is averaged.

The total risk/dose (either cancer risk or hazard index) is the sum of the risks/doses for all of the site-specific exposure pathways and contaminants.

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk range of 10^{-4} to 10^{-6}. The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the Hazard Index) for the toxicity resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of this quantitative estimate with the EPA standard Hazard Index of unity (1). The evaluation of the health hazard due to radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA, 1989) and the RESRAD Manual (ANL, 1993). Table 2 shows the default parameter values suggested for used by SNL at ER sites, based on the selected land use scenario. References are given at the end of the table indicating the source for the chosen parameter values. The intention of SNL is to use default values that are consistent with regulatory guidance and consistent with the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are suggested for use for the various exposure pathways based on the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

Summary

SNL proposes the described default exposure routes and parameter values for use in risk assessments at sites that have an industrial, recreational or residential future land-use scenario. There are no current residential land-use designations at SNL ER sites, but this scenario has been requested to be considered by the NMED. For sites designated as industrial or recreational land-use, SNL will provide risk parameter values based on a residential land-use scenario to indicate the effects of data uncertainty on risk value calculations or in order to potentially mitigate the need for institutional controls or restrictions on Sandia ER sites. The parameter values are based on EPA guidance and supplemented by information from other government sources. The values are generally consistent with those proposed by Los Alamos National Laboratory, with a few minor variations. If these exposure routes and parameters are acceptable, SNL will use them in risk assessments for all sites where the assumptions are consistent with site-specific conditions. All deviations will be documented.

Table 2. Default Parameter Values for Various Land Use Scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure frequency (d/y)	***	***	***
Exposure duration (y)	30[a,b]	30[a,b]	30[a,b]
Body weight (kg)	70[a,b]	56[a,b]	70 adult[a,b] 15 child
Averaging Time (days) for carcinogenic compounds (=70 y x 365 d/y) for noncarcinogenic compounds (=ED x 365 d/y)	25550[a] 10950	25550[a] 10950	25550[a] 10950
Soil Ingestion Pathway			
Ingestion rate	100 mg/d[c]	6.24 g/y[d]	114 mg-y/kg-d[a]
Inhalation Pathway			
Inhalation rate (m^3/yr)	5000[a,b]	146[d]	5475[a,b,d]
Volatilization factor (m^3/kg)	chemical specific	chemical specific	chemical specific
Particulate emission factor (m^3/kg)	1.32E9[a]	1.32E9[a]	1.32E9[a]
Water Ingestion Pathway			
Ingestion rate (L/d)	2[a,b]	2[a,b]	2[a,b]
Food Ingestion Pathway			
Ingestion rate (kg/yr)	NA	NA	138[b,d]
Fraction ingested	NA	NA	0.25[b,d]
Dermal Pathway			
Surface area in water (m^2)	2[b,e]	2[b,e]	2[b,e]
Surface area in soil (m^2)	0.53[b,e]	0.53[b,e]	0.53[b,e]
Permeability coefficient	chemical specific	chemical specific	chemical specific

*** The exposure frequencies for the land use scenarios are often integrated into the overall contact rate for specific exposure pathways. When not included, the exposure frequency for the industrial land use scenario is 8 h/d for 250 d/y; for the recreational land use, a value of 2 hr/wk for 52 wk/y is used (EPA, 1989b); for a residential land use, all contact rates are given per day for 350 d/y.

[a] RAGS, Vol 1, Part B (EPA, 1991).

[b] Exposure Factors Handbook (EPA, 1989b)

[c] EPA Region VI guidance.

[d] For radionuclides, RESRAD (ANL, 1993) is used for human health risk calculations; default parameters are consistent with RESRAD guidance.

[e] Dermal Exposure Assessment, 1992.

References

ANL, 1993, Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0, ANL/EAD/LD-2, Argonne National Laboratory, Argonne, IL.

DOE, Environmental Assessment of the Environmental Restoration Project at Sandia National Laboratories/New Mexico, US. Dept. of Energy, Kirtland Area Office, 1996.

EPA, 1989a, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, EPA/540-1089/002, US Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

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EPA, 1991, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B), EPA/540/R-92/003, US Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

EPA, 1992, Dermal Exposure Assessment: Principles and Applications, EPA/600/8-91/011B, Office of Research and Development, Washington, D.C.